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**AMERICAN GEOLOGICAL INSTITUTE**

## GEOSCIENCE ABSTRACTS

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Vol. 3, No. 2 | Abstracts 3-352 to 3-666 | February 1961

## CONTENTS

PAGE

1. Geologic Maps, Areal and Regional Geology (including Guidebooks) 1
2. Geomorphology . . . . . 11
3. Structural Geology . . . . . 16
4. Stratigraphy and Historical Geology . . . . . 17
5. Paleontology . . . . . 19
6. Geophysics . . . . . 22
7. Geochemistry . . . . . 27
8. Mineralogy and Crystallography . . . . . 30
9. Igneous and Metamorphic Petrology . . . . . 37
10. Sedimentary Petrology . . . . . 39
11. Geohydrology . . . . . 40
12. Mineral Deposits (including Geochemical Prospecting) . . . . . 44
13. Fuels . . . . . 48
14. Engineering Geology . . . . . 50
15. Miscellaneous . . . . . 51

## SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Alabama, Geological Survey, Bulletin; County Report; Information Series. University.
American Engineer (National Society of Professional Engineers). Washington, D.C.
American Geological Institute, Report. Washington, D.C.
American Journal of Science. New Haven, Connecticut.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
American Scientist. Easton, Pennsylvania.
Arctic (Arctic Institute of North America). Montreal.
B.C. Professional Engineer (Association of Professional Engineers of British Columbia). Vancouver.
California, Division of Mines, Mineral Information Service; Special Report. San Francisco.
California, University, Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Geological Survey, Bulletin; Geophysics Paper; Map; Memoir; Paper. Ottawa.
Canadian Mineralogist (Mineralogical Association of Canada). Ottawa.
Canadian Mining Journal. Gardenvale, Quebec.
Colorado School of Mines, Mineral Industries Bulletin. Golden.
Geographical Review (American Geographical Society). New York.
Illinois State Geological Survey, Bulletin; Circular. Urbana.
International Geology Review (American Geological Institute). Washington, D.C.
Journal of Geology. Chicago.
Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
Kansas, State Geological Survey, Bulletin; Oil and Gas Investigations. Lawrence.
Kentucky Geological Survey, Report of Investigations. Lexington.
Kristallografiya. Soviet Physics: Crystallography; a translation of the journal Crystallography of the Academy of Sciences, U.S.S.R. (American Institute of Physics). New York.
Michigan, University, Museum of Paleontology, Contributions. Ann Arbor.
Mineral Industries Journal (Virginia Polytechnic Institute). Blacksburg, Virginia.
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National Geographic Magazine. Washington, D.C.
New Mexico, State Engineer Office, Technical Report. Santa Fe.
New York Times. New York.
Ohio Journal of Science. Columbus.
Ohio State University, Institute of Geodesy, Photogrammetry and Cartography, Publication. Columbus.
Ontario, Dept. of Mines, Annual Report; Industrial Mineral Circular. Toronto.
Pennsylvania Geological Survey, Information Circular. Harrisburg.
Photogrammetric Engineering (American Society of Photogrammetry). Washington, D.C.
Science. Washington, D.C.
Scientific American. New York.
Seismological Society of America, Bulletin. Berkeley, California.
Society of Vertebrate Paleontology, Bibliography of Vertebrate Paleontology and Related Subjects. Cambridge, Massachusetts.
Southeastern Geology (Dept. of Geology, Duke University). Durham, North Carolina.
Soviet Geography: Review & Translation (American Geographical Society). New York.
U.S. Beach Erosion Board, Technical Memorandum. Washington, D.C.
U.S. Geological Survey, Bulletin; Geophysical Investigations Map; Miscellaneous Investigations Map; Professional Paper; Reports, Open-File Series; Trace Elements Memorandum Report. Washington, D.C.
U.S. Waterways Experiment Station, Vicksburg, Miss., Miscellaneous Paper.
Virginia Polytechnic Institute, Bulletin; Bulletin, Engineering Experiment Station Series. Blacksburg.
Washington, Division of Mines and Geology, Bulletin. Olympia.

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# GeoScience Abstracts

## 1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

### PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-427 through 3-431, 3-433, 3-434, 3-436, 3-437; Geomorphology 3-463; Geophysics 3-500; Geohydrology 3-612.

Correction: GeoScience Abstracts 3-58, in v. 3, no. 1, Jan. 1961, should read Ambler quadrangle, not Amber quadrangle.

3-352. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 838, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 62°30'-63°W., 1960.

3-353. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 839, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 62°30'-63°W., 1960.

3-354. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 844, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 62°-62°30'W., 1960.

3-355. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 845, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 62°-62°30'W., 1960.

3-356. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 847, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 61°30'-62°W., 1960.

3-357. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 848, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 61°30'-62°W., 1960.

3-358. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 849, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 61°30'-62°W., 1960.

3-359. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1015, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°30'N., long. 63°-64°W., 1960.

3-360. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1016, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-48°N., long. 63°-64°W., 1960.

3-361. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1017, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°30'N., long. 62°-63°W., 1960.

3-362. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1018, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-48°N., long. 62°-63°W., 1960.

3-363. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1019, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°30'N., long. 61°-62°W., 1960.

3-364. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1020, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-48°N., long. 61°-62°W., 1960.

3-365. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1021, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°30'N., long. 60°-61°W., 1960.

3-366. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1022, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-48°N., long. 60°-61°W., 1960.

3-367. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1023, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°30'N., long. 59°-60°W., 1960.

3-368. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1024, aeromagnetic map, scale 1:126,720, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-48°N., long. 59°-60°W., 1960.

3-369. Armstrong, John E. SURFICIAL GEOLOGY, CHILLIWACK (WEST HALF), NEW WESTMINSTER AND YALE DISTRICTS, BRITISH COLUMBIA: Canada, Geol. Survey, Map 53-1959, scale 1:63,360, descriptive notes, 1960.

Preliminary series geological map of about 5,000 sq. mi. on lower Fraser River near Vancouver. The map is bordered by the Cascade Mountains and the Chilliwack River on the S. and the southern limits of the Coast Mountains on the N. Tertiary bedrock is exposed. Pleistocene and Recent glacial and nonglacial sediments comprise the remaining area. A Cordilleran ice-sheet is known to have covered the area more than 12,000 years ago leaving a thin mantle, now preserved only on the higher parts of the area. Extensive postglacial deposits consist of stream, flood plain, and slopewash materials; the youngest, the Salish, are still in process of formation.--M. Stewart.

3-370. Leech, G.B., and others. **GEOLOGY, FERNIE (WEST HALF), KOOTENAY DISTRICT, BRITISH COLUMBIA**: Canada, Geol. Survey, Map 11-1960, scale 1:126,720, descriptive notes, 1960, 3 refs.

Preliminary series geological map of about 13,000 sq.mi. near the B.C., Alberta and international boundaries. The Rocky Mountain Trench near the center of the area is bordered on the W. by the Purcell Mountains and on the E. by the Rocky Mountains. In the Purcell Mountains the Precambrian sediments, between the top of the Kitchener argillite and the topmost lava, comprise 2 main divisions: 1) nondolomitic purple quartzites and argillites, 2) dolomitic argillites and quartzites. The Dutch Creek formation of the NW. part is equivalent to the Gateway argillites and siltstones, Phillips quartzites, and the Roosville argillites and siltstones of the S. and E. Windemere conglomerate forms the probable Precambrian-Paleozoic contact. Stromatalites are conspicuous in beds of dolomite and limestone of the Gateway and Kitchener formations. Paleozoic systems are represented, followed by Triassic siltstone and silty shale, and Cretaceous(?) and Tertiary(?) quartz monzonite. A major reverse fault, the Moyie fault, is probably an oblique thrust fault whose history may date from Precambrian time. Displacement of contacts and stratigraphic displacement are the cumulative effect of numerous faults. Several flexures and asymmetrical folds are believed to reflect a fold zone related to eastward thrusting.--M. Stewart.

3-371. Gabrielse, Hubert. **GEOLOGY, KECHIKA, CASSIAR DISTRICT, BRITISH COLUMBIA**: Canada, Geol. Survey, Map 57-1959, scale 1:253,440, descriptive notes, 1960.

Preliminary series geological map of about 5,000 sq.mi. E. of Fort Nelson and the Alaska Highway, near the boundary between British Columbia and the Northwest Territories. The Rocky Mountain Trench crosses the map-area, with the Cassiar Mountains on the W. and Rocky Mountains to the NE. Precambrian comprises limestone, quartzites, phyllites, and schists. The lower Cambrian, consisting of quartzite, conglomerate, siltstone, slate, and shale rests conformably on the Precambrian and is in turn overlain by the Cambrian and Ordovician limestones and dolomites. Devonian and Mississippian argillite, chert and greenstones unconformably overlie Silurian rocks. Fossiliferous carbonate rocks are typically Mississippian whereas the Permian(?) is comprised mainly of greenstone and hornfels. Igneous rocks of Cretaceous and Tertiary age are overlain by Pleistocene glacial, glaciofluvial and fluvial deposits. Plunging, overturned, and asymmetrical folds are evident particularly in Lower Cambrian and Precambrian rocks. Northwesterly trending faults truncate at acute angles the strata and structures of the Cassiar and Rocky Mountains.--M. Stewart.

3-372. Campbell, R.B. **GEOLOGY, QUESNEL LAKE (WEST HALF), CARIBOO DISTRICT, BRITISH COLUMBIA**: Canada, Geol. Survey, Map 59-1959, scale 1:253,440, descriptive notes, 1960, ref.

Preliminary series geological map of about 3,000 sq.mi. SE. of Prince George. The Cariboo group, of argillite, quartzite, slate, and phyllite, formerly thought to be Precambrian, is now considered to be Cambrian and later. Rocks of the Cache Creek group, mainly limestone and chert, are dated as Permian and(?) earlier. Mesozoic rocks, dominantly volcanic, were formerly assigned a probable Jurassic age. Now, however, Triassic and possibly Cretaceous components are also included. Upper Triassic sedimentary rocks are overlain by conglomerate which forms a conformable and gradational contact with the "purple" Lower Jurassic volcanic rocks. The purple color results from abundant accessory hematite. In otherwise similar green volcanic rocks, magnetite is abundant. The Lower Jurassic conglomerate and sandstone seem to be folded in synclines. All Tertiary sedimentary rocks are older than the Tertiary, (Miocene and/or Pliocene) basalts. Siliceous volcanic rocks are considered to be Paleocene or Eocene, based on lithological correlation. Except for large masses of granite in the northeastern part of the area, plutonic rocks occur in small isolated exposures. Considerable Au placer mining activity has been carried on in the past; some short cross-fiber asbestos occurs.--M. Stewart.

3-373. Fahrig, W.F. **GEOLOGY, SNEGAMOOK LAKE, COAST OF LABRADOR, NEWFOUNDLAND**: Canada, Geol. Survey, Map 1079A, scale 1:253,440, descriptive notes, 1959.

Geological map of some 2,500 sq.mi., near Hopedale, NW. of Goose Bay, Labrador. The oldest known rocks in the map-area are Archean granitoid gneisses, anorthosite, and related gabbroic rocks. Most rocks of the Croteau group are volcanic except for a few showings of black pyritic carbonaceous shale, sandstone, and conglomerate. The unmetamorphosed rocks of the Seal group consist of continental and marine sediments and volcanic rocks intruded by diabasic and gabbroic sills. The Seal group forms an arcuate E.-trending synclinorium which is overturned towards the N. and truncated on the S. by a zone of moderately dipping thrust faulting. Cross-bedding and ripple marks were also observed. A number of E.-W. faults have been suggested within and on the S. border of the Seal group. Chalcopyrite, chalcocite, bornite, native Cu, galena, and sphalerite have been reported in the rocks of the Croteau group.--M. Stewart.

3-374. Fraser, J.A., and others. **GEOLOGY, NORTH-CENTRAL DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES**: Canada, Geol. Survey, Map 18-1960, 2 sheets, scale 1:506,880, descriptive notes, 1960, 4 refs.

Preliminary series geological map of about 65,000 sq.mi., between Great Bear Lake, Amundsen Gulf, and Victoria Island. All of the Yellowknife group, the oldest sedimentary unit, has been highly deformed and granitized or intruded by Archean granite. The Epwarth formation, lies unconformably on granitic rocks and is composed mainly of quartzite, sandstone, dolomite, graywacke and conglomerate. Some of the dolomite contains abundant stromatolites. Cameron Bay conglomerate is in unconformable contact with the Hornby Bay dolomite sandstone, in turn overlain by basaltic flows which are often amygdaloidal. The Coppermine River series consists of layered sandstone, quartzite, shales, dolomites, with minor limestone and gypsum. Diabase dikes and sills plus the Muskox complex of dunite, peridotite, and pyroxenite, completes the Proterozoic sequence. Paleozoic sandstone, shales, and dolomites contain possible Cambrian wormlike remains and Devonian fossils. A Mesozoic sequence containing sandstone, shale, and some lignite overlies the Paleozoic rocks. Many faults cut the Proterozoic and older rocks in a northeastern trend. Pitchblende, Ag, nickeliferous sulfides, native Cu, chalcocite, bornite, covellite, pyrite, pyrrhotite, and Mn-bearing material are present in varying amounts.--M. Stewart.

3-375. Weeks, Ludlow J. GEOLOGY, CAPE CANSO, GUYSBOROUGH AND RICHMOND COUNTIES, NOVA SCOTIA: Canada, Geol. Survey, Map 1074A, scale 1:63,360, descriptive notes, 1960, ref.

Geological map of about 200 sq. mi. around the Strait of Canso, N. of Liscomb and S. of Louisburg. Rocks of the Fourchu are correlated on lithological grounds as late Proterozoic. The Goldenville formation forms the lower part of the Meguma series, assumed to be pre-Devonian in age. Shales and slates of the Meguma series are believed to have been particularly susceptible to granitization and injection. Devonian granitic rocks cut the Goldenville quartzites sharply, but toward the S. are separated by a transition zone of granitized and injected bedded rocks. Conglomerate, minor sandstone, and shale lie with profound unconformity on Fourchu and granitic rocks.--M. Stewart.

3-376. Canada, Geological Survey. MALIGNANT COVE, ANTIGONISH AND KINGS COUNTIES, NOVA SCOTIA AND PRINCE EDWARD ISLAND: Its: Geophysics Paper 841, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 45°45'-46°N., long. 62°-62°30'W., 1960.

3-377. Canada, Geological Survey. MERIGOMISH, PICTOU AND ANTIGONISH COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 840, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 45°30'-45°45'N., long. 62°-62°30'W., 1960.

3-378. Canada, Geological Survey. PORT HOOD, INVERNESS COUNTY, NOVA SCOTIA: Its: Geophysics Paper 846, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 61°30'-62°W., 1960.

3-379. Donaldson, J.A. GEOLOGY, TROUT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Map 58-1959, scale 1:253,440, descriptive notes, 1960, 10 refs.

Preliminary series geological map of about 5,500 sq. mi. in the Kenora district. Precambrian rocks include slate, argillite, quartzite, graywacke, and conglomerate. Banded Fe-formation consisting of fine-grained interbeds of quartz, magnetite, and iron silicates also occurs. Because of strong magnetic attraction, the belts of Fe-formation commonly can be traced in drift-covered areas. Massive, medium- to coarse-grained basic intrusive rocks occur as scattered plugs, sills, and irregular bodies. Granite, quartz monzonite, and granodiorite compose large masses that truncate foliations in older rocks. They are characterized by a paucity of ferromagnesian minerals. Aplite and pegmatite dikes of similar composition have been seen to cut all other rock types. Lamprophyre dikes cut all other rocks except for a few younger aplites and pegmatites. There are at least 2 periods of folding, one is NE.-trending, the other is a crossfolding along a NW.-trending axis. Two near vertical regional joint sets cross all rocks in the map-area. Zones of mylonization and rock alteration mark the fault zones. There are 5 producing Au mines in the Red Lake district. Most Au occurs in silicified zones and quartz carbonate veinlets. The major ore bodies are restricted to shear and fracture zones in volcanic and basic intrusive rocks.--M. Stewart.

3-380. Frarey, M.J. GEOLOGY, WAKWEKOBI LAKE, ALGOMA DISTRICT, ONTARIO: Canada, Geol. Survey, Map 3-1960, scale 1:63,360, descriptive notes, 1960, 5 refs.

Preliminary series geological map of about 6,500 sq. mi. N. of the railway, between Sault Ste. Marie and Sudbury. Precambrian rocks of this map lie in the Huronian belt of Ontario. Granite and granite gneiss are typically Archean, whereas Mississagi quartzite, Bruce conglomerate and limestone, Gowganda graywacke and argillite, and Lorrain quartzite and conglomerate are of Proterozoic age. The various basic intrusive rocks are intergradational, the larger intrusions appearing to be subconcordant sheets. There are also numerous small, steeply inclined dikes. The sedimentary formations are very gently folded. Numerous quartz veins, bearing various amounts of chalcopyrite, bornite, specularite, and carbonate, are scattered over the area.--M. Stewart.

3-381. Canada, Geological Survey, and Ontario, Dept. of Mines. BERENS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 855, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 93°30'-94°W., 1960.

3-382. Canada, Geological Survey, and Ontario, Dept. of Mines. CRITCHELL LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 857, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long 93°30'-94°W., 1960.

3-383. Canada, Geological Survey, and Ontario, Dept. of Mines. D'ORSONNENS LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 961, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 88°-88°30'W., 1960.

3-384. Canada, Geological Survey, and Ontario, Dept. of Mines. FAVOURABLE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 859, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 93°30'-94°W., 1960.

3-385. Canada, Geological Survey, and Ontario, Dept. of Mines. FORT HOPE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 974, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 87°30'-88°W., 1960.

3-386. Canada, Geological Survey, and Ontario, Dept. of Mines. GULLROCK LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 851, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 93°30'-94°W., 1960.

3-387. Canada, Geological Survey, and Ontario, Dept. of Mines. KABANIA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 966, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 88°-88°30'W., 1960.

3-388. Canada, Geological Survey, and Ontario, Dept. of Mines. KANUCHUAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 979, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 87°30'-88°W., 1960.

3-389. Canada, Geological Survey, and Ontario, Dept. of Mines. KAWITOS LAKE, THUNDER BAY AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 963, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 88°-88°30'W., 1960.

3-390. Canada, Geological Survey, and Ontario, Dept. of Mines. KELLOW LAKE, THUNDER BAY AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 972, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 87°30'-88°W., 1960.

3-391. Canada, Geological Survey, and Ontario, Dept. of Mines. KENNEDY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 858, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 93°30'-94°W., 1960.

3-392. Canada, Geological Survey, and Ontario, Dept. of Mines. KIRKNESS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 854, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long 93°30'-94°W., 1960.

3-393. Canada, Geological Survey, and Ontario, Dept. of Mines. LANSDOWNE HOUSE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 976, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 87°30'-88°W., 1960.

3-394. Canada, Geological Survey, and Ontario, Dept. of Mines. MACHAWAIAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 965, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 88°-88°30'W., 1960.

3-395. Canada, Geological Survey, and Ontario, Dept. of Mines. McINNES LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 856, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 93°30'-94°W., 1960.

3-396. Canada, Geological Survey, and Ontario, Dept. of Mines. MAHAMO LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 971, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 87°30'-88°W., 1960.

3-397. Canada, Geological Survey, and Ontario, Dept. of Mines. MAKOKI LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 970, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 87°30'-88°W., 1960.

3-398. Canada, Geological Survey, and Ontario, Dept. of Mines. MAMEIGWESS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 978, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 87°30'-88°W., 1960.

3-399. Canada, Geological Survey, and Ontario, Dept. of Mines. MOJIKIT LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 960, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 88°-88°30'W., 1960.

3-400. Canada, Geological Survey, and Ontario, Dept. of Mines. NANKIKA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 967, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 88°-88°30'W., 1960.

3-401. Canada, Geological Survey, and Ontario, Dept. of Mines. NUNGESSER AND COLI LAKES, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 853, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 93°30'-94°W., 1960.

3-402. Canada, Geological Survey, and Ontario, Dept. of Mines. OPIKEIGEN LAKE, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 964, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 88°-88°30'W., 1960.

3-403. Canada, Geological Survey, and Ontario, Dept. of Mines. RED LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 852, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 93°30'-94°W., 1960.

3-404. Canada, Geological Survey, and Ontario, Dept. of Mines. SAGIMINNIS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 968, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long. 88°-88°30'W., 1960.

3-405. Canada, Geological Survey, and Ontario, Dept. of Mines. SIM LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 962, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 88°-88°30'W., 1960.

3-406. Canada, Geological Survey, and Ontario, Dept. of Mines. STARK LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 975, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 87°30'-88°W., 1960.

3-407. Canada, Geological Survey, and Ontario, Dept. of Mines. TRIANGULAR LAKE, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 973, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 87°30'-88°W., 1960.

3-408. Canada, Geological Survey, and Ontario, Dept. of Mines. WAPIKOPA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 969, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 88°-88°30'W., 1960.

3-409. Canada, Geological Survey, and Ontario, Dept. of Mines. WAPITOTEM LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 977, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 87°30'-88°W., 1960.

3-410. Canada, Geological Survey, and Ontario, Dept. of Mines. WEGG LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 850, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 93°30'-94°W., 1960.

3-411. Canada, Geological Survey. BOUGHTON ISLAND, KINGS COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 842, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 62°-62°30'W., 1960.

3-412. Canada, Geological Survey. SOURIS, KINGS COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 843, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 62°-62°30'W., 1960.

3-413. Labrador Mining and Exploration Co., H.R. Wynne-Edwards, and J.A. Donaldson. GEOLOGY, MICHIKAMAU LAKE (WEST HALF), QUEBEC-NEWFOUNDLAND: Canada, Geol. Survey, Map 2-1960, scale 1:253,440, descriptive notes, 1960, ref.

Preliminary series geological map of about 3,000 sq. mi., E. of Schefferville and W. of the Quebec-Newfoundland boundary. Precambrian bedrock exposures are the main interest. Hills along the eastern border are underlain by hypersthene syenite. To the W., these rocks grade into a leucocratic granitic phase, where amphibolite forms the only hills. Clastic rocks are dominantly graywacke, grading up into coarse arkosic quartzite. Shale and phyllite, then dolomite with stromatalite zones, are found above this. Greenstones and some pillow lavas form conformable layers in the sedimentary rocks. The Sokohoman embraces all the Fe formation and ferruginous graywacke and slate of the area. Gabbro sills intrude all units and are in places indistinguishable from coarse greenstones. Diabase dikes intrude both gneisses and sediments. In the northern part of the area the rocks of the Labrador trough are in contact with gneisses of a fault zone. Pyrite, pyrrhotite, chalcopyrite, cross fiber asbestos, and Fe formations are of economic interest.--M. Stewart.

3-414. Eade, K. E., and others. GEOLOGY, NICHICUN-KANIAPISKAU, NEW QUEBEC: Canada, Geol. Survey, Map 56-1959, scale 1:506,880, descriptive notes, 1960, 8 refs.

Preliminary series geological map of about 12,500 sq. mi. in northern Quebec, E. of Hudson and James bays, 45 mi. W. of Schefferville. The area is entirely Precambrian. Archean rocks include volcanic rocks, mostly basic in composition and commonly altered to greenstone and amphibolites; also granites, gneisses, schists, and amphibolites. Proterozoic rocks comprise argillites, slates, sandstones, and arkoses. Fe-formation of jasper hematite has been found at a few outcrops of Proterozoic rocks. Most of the areas of sedimentary rocks represent down-faulted blocks that cover the granite and granite-gneiss unconformably. Gabbro dikes are present in limited number and appear to be related to gabbro sills intruding the sandstones and quartzites of the younger Proterozoic (Otish Mountain group). Major and minor folds affect the Archean, and a number of parallel NE.-trending faults show a predominantly vertical displacement. This zone of faulting parallels the suggested line of the "Grenville Front."--M. Stewart.

3-415. Lee, Hulbert A., and others. SURFICIAL GEOLOGY, SAKAMI LAKE, (FORT GEORGE-GREAT WHALE AREA), NEW QUEBEC: Canada, Geol. Survey, Map 52-1959, scale 1:506,880, descriptive notes, 1960, 9 refs.

Preliminary series surficial geology map of about 5,000 sq. mi. on the E. side of James and Hudson bays. The surficial deposits comprise, from bottom to top: bedrock, till, glaciofluvial gravel, marine clay and silt, alluvial gravel and sand, peat. Radiocarbon dates from samples collected in the map-area give some information on the rate of emergence of the land surface.--M. Stewart.

3-416. Wheeler, John O., and others. GEOLOGY, FINLAYSON LAKE, YUKON TERRITORY: Canada, Geol. Survey, Map 8-1960, scale 1:253,440, descriptive notes, 1960.

Preliminary series geological map of about 4,500 sq. mi., NE. of Whitehorse. Lower Cambrian quartzites and limestones are overlain by phyllites which are in turn overlain by graptolitic slates ranging in age from Lower Ordovician to Middle Silurian. Associated with the phyllites are numerous bodies of greenstones. Some seem to be contemporaneous with the phyllites, others are probably younger. Overturned Lower Silurian graptolitic siltstone beds are overlain by volcanic breccia and Silurian and Devonian dolomite with local lenses of chert. Mississippian rocks consist of siliceous slate and shale, volcanic rocks, greenstone, metadiorite and heterogeneous, shattered hornblende syenite. Middle and Upper Cambrian phyllites are in some localities intruded by Jurassic and/or Cretaceous granitic rocks. Paleocene shale, sandstone and conglomerate, Tertiary basalt flows, and Quaternary alluvial deposits compose the Cenozoic rocks. The dominant structure is the Tintina fault. It separates the folded and faulted but relatively unmetamorphosed Paleozoic to the SW. from the metamorphic and granitic rocks to the NE.--M. Stewart.

3-417. Wheeler, John O., and others. GEOLOGY, QUIET LAKE, YUKON TERRITORY: Canada, Geol. Survey, Map 7-1960, scale 1:253,440, descriptive notes, 1960.

Preliminary series geological map of about 5,000 sq. mi., NE. of Whitehorse. Lower Cambrian quartzites are overlain by limestone with Lower Cambrian archeocyathids. This in turn is overlain by phyllite. Lower Ordovician to Middle Silurian graptolites were collected from a black slate, siltstone, and volcanic unit. Thick-bedded dolomite with lenses of chert compose the Silurian-Devonian formations. Most of the volcanic rocks either overlie or are intercalated with Mississippian siliceous slate and shale and hence are probably Mississippian or earlier. Current-bedded, ripple-marked limestone is also of Mississippian age. Jurassic and/or Cretaceous biotite granodiorite, quartz monzonite, and gneiss are clearly intrusive in most places. The Cenozoic is composed of Paleocene slate, Tertiary basalt flows, and Quaternary alluvial deposits. The Porcupine thrust, Tintina fault, and the St. Cyr fault are the main deformations. No significant mineralization was noted.--M. Stewart.

3-418. Lathram, E.H., and others. PROGRESS MAP OF THE GEOLOGY OF ADMIRALTY ISLAND, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-323, scale 1:250,000, contour interval 200 ft., lat. 57°-58°N., long. 134°-134°30'W., 1960.

This map shows the reconnaissance geology of an island about 2,100 sq. mi. in area, S. of Juneau, southeastern Alaska. The geology was mapped largely in 1959 as part of the U.S. Geological Survey's long-range minerals program. The location of both previously known and newly discovered sites of mineralization are shown, and a tabulation of X-ray spectrographic analyses of selected mineralized rock is included.--U.S. Geol. Survey.

3-419. Gray, Carlyle, and Vincent C. Shepps. GEOLOGIC MAP OF PENNSYLVANIA: Pennsylvania Geol. Survey, 2 sheets, cross secs., scale 1:250,000, 1960.

This newly compiled, full-color map shows the distribution of approximately 130 rock units and the boundaries of the glacial advances in Pennsylvania. Colors have been chosen to best show individual rock units and to emphasize the structure of the rocks.

This map brings together all of the published and unpublished data available up to the time of its publication; old mapping, done on an open base, has been adjusted to fit present day topographic maps of the areas. More than twice as many units are shown on this map as on the previous edition. Cross sections were selected which also bring up to date the thinking on the structure of the state and show the data found on the thickness and character of units by the deep drilling which has taken place since the last edition of this map.--Auth.

3-420. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE BEDMINSTER QUADRANGLE, BUCKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-260, scale 1:24,000, contour interval 25 gammas, lat. 40°22'30"-40°30'N., long. 75°07'30"-75°15'W., 1960.

3-421. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE COLLEGEVILLE QUADRANGLE, MONTGOMERY COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-210, scale 1:24,000, contour interval 25 gammas, lat. 40°07'30"-40°15'N., long. 75°22'30"-75°30'W., 1960.

3-422. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE DOYLESTOWN QUADRANGLE, BUCKS AND MONTGOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-263, scale 1:24,000, contour inverval 25 gammas, lat. 40°15'-40°22'30"N., long. 75°07'30"-75°15'W., 1960.

3-423. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE LANSDALE QUADRANGLE, MONTGOMERY COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-264, scale 1:24,000, contour interval 25 gammas, lat. 40°07'30"-40°15'N., long. 75°15'-75°22'30"W., 1960.

3-424. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE LUMBERVILLE QUADRANGLE, BUCKS COUNTY, PENNSYLVANIA, AND HUNTERDON COUNTY, NEW JERSEY: U.S. Geol. Survey, Geophys. Inv. Map GP-261, scale 1:24,000, contour interval 25 gammas, lat. 40°22'30"-40°30'N., long. 75°-75°07'30" W., 1960.

3-425. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF THE TELFORD QUADRANGLE, MONTGOMERY AND BUCKS COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-262, scale 1:24,000, contour interval 25 gammas, lat. 40°15'-40°22'30"N., long. 75°15'-75°22'30"W., 1960.

3-426. Bramkamp, R.A., and Leon F. Ramirez. GEOGRAPHIC MAP OF THE DARB ZUBAYDAH

QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-202B, scale 1:500,000, lat. 28°-32°N., long. 42°-45°E., 1960.

## PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 3-611, 3-612.

3-427. Stott, Donald F. CRETACEOUS ROCKS BETWEEN SMOKY AND PINE RIVERS, ROCKY MOUNTAIN FOOTHILLS, ALBERTA AND BRITISH COLUMBIA: Canada, Geol. Survey, Paper 60-16, 52 p., Map 21-1960 (in pocket), scale 1:253,440, diag., table, 1960, 22 refs.

Preliminary report providing information on the distribution and lithology of the Lower and Upper Cretaceous of the area. Paleozoic rocks are exposed only in the main ranges of the Rocky Mountains; Triassic and Jurassic rocks outcrop only in a few localities. The Cretaceous formations are described in detail both in the text and appendix of the paper. Lithologically, the Lower and Upper Cretaceous formations are predominantly marine shale, siltstone, and sandstone. The dominant structural features of the foothills are complex northwesterly-trending folds cut by SW.-dipping strike-thrust faults. Deformation moderately intense throughout the foothills decreases eastward from the main mountain ranges. Basically the foothills are formed by a large anticlinorium with major anticlines within it. The northwestern ends of the anticlines are terminated by faults and folds. The southern end terminates in small complex folds. Within the eastern part of the foothills lie 3 major synclines. These are relatively simple, broad, and shallow structures. Many wells have been drilled in the eastern part of the foothills, and some discoveries have been made in the sands of the Lower Cretaceous Fort St. John group in the plains. --M. Stewart.

3-428. Poole, W.H. HAYESVILLE AND McNAMEE MAP-AREAS, YORK, NORTHUMBERLAND, AND CARLETON COUNTIES, NEW BRUNSWICK: Canada, Geol. Survey, Paper 60-15, 10 p., Maps 19-1960 and 20-1960 (in pocket), scale 1:63,360, 1960, 4 refs.

Preliminary series paper and maps describing the geology of 2 adjacent areas near the center of the belt of granitic intrusions and highly deformed lower and middle Paleozoic rocks that extends northeasterly across New Brunswick from St. Croix River to Chaleur Bay. Ordovician and Silurian sedimentary and minor volcanic rocks have been intruded by Devonian(?) granitic bodies. Undeformed Carboniferous sediments unconformably overlie the Silurian rocks. Occurrences of galena, sphalerite, chalcopyrite, wolframite, and molybdenite have been reported in the area. Manganiferous carbonate nodules occur in Ordovician rocks on SW. Miramichi River. A thick mantle of till covers most hills, and the whole area was completely covered by ice at least once during the Pleistocene.--P. Harker.

3-429. Smitheringale, W.G. GEOLOGY OF NICTAUX-TORBROOK MAP-AREA, ANNAPOLIS AND KINGS COUNTIES, NOVA SCOTIA: Canada, Geol. Survey, Paper 60-13, 32 p., Map 14-1960 (in pocket) scale 1:63,360, 2 tables, 1960, 18 refs.

Bedrock of the map-area comprises sedimentary, minor volcanic, and intrusive rocks of Paleozoic age, unconformably overlain by sedimentary and volcanic rocks of Triassic age. The Pleistocene geology consists of erratics from the continental ice-sheet which moved in a southeasterly direction. Paleozoic sedimentary and volcanic rocks are divided into 5 formations ranging in age from Ordovician to Lower Devonian. The sediments are predominantly shales, slates, and minor quartzites. Fe beds are included in the Lower Devonian strata. In late Lower or Middle Devonian time, the Paleozoic strata were affected by the Acadian orogeny. This resulted in a NE.-trending, closed, symmetrical syncline called the Torbrook syncline. Tight folding and vertical cleavage occur in the trough of this syncline. These rocks were intruded by numerous mafic sills and dikes, followed by faulting and intrusion of the Nova Scotia granite batholith. Displacements on the limbs of the Torbrook syncline are interpreted as being due to 2 different fault movements. Fe occurs on both limbs of the syncline, but the deposits are uneconomic by present standards. Minor Mn deposits occur, and granite has been quarried locally for ornamental purposes.--M. Stewart.

3-430. Young, W.L. GEOLOGY OF THE BENNETT-TANNER AREA: Ontario Dept. Mines, Ann. Rept., v. 69, pt. 4, 17 p., 5 illus., 3 maps incl. col. geol. map (in pocket), scale 1:31,680, 2 secs., table, 1960, refs.

The Bennett-Tanner area is in the Rainy River district, northwestern Ontario. The consolidated rocks are Precambrian. The oldest are steeply dipping and metamorphosed Keewatin formations of tuff-breccia conglomerate (Seine series), lavas and tuffs with intercalated Fe formations, and biotite schists derived from the volcanics. All are intruded by quartz-feldspar and hornblende orthogneiss. The youngest rocks are intrusives varying from granite to hornblendite. Pleistocene and Recent deposits mantle areas of the older rocks.

The Keewatin rocks have been tightly folded into an isoclinal syncline, which plunges steeply and splits into a smaller anticline and syncline. Northeasterly and northwesterly right-strike separation faults are prominent.

Many small, barren quartz veins intrude the Keewatin rocks. Sulfides occur in and near the younger basic intrusives and in silicified shears.--Auth.

3-431. Satterly, J. GEOLOGY OF THE DYMENT AREA: Ontario Dept. Mines, Ann. Rept., v. 69, pt. 6, 32 p., 11 illus., 3 maps incl. col. geol. map (in pocket), scale 1:31,680, 5 tables, 1960, refs.

This report deals with the general, structural, and economic geology of Melgund, Revell, and Hyndman townships, district of Kenora. Previous reconnaissance geology was carried out in 1906. Precambrian rocks exposed are volcanics cut by diorite-to-granite intrusives, and late diabase dikes. The volcanic rocks exhibit 2 periods of metamorphism; an earlier period of low-grade metamorphism is shown by mineral assemblages of the greenschist facies, and upon this is superimposed thermal metamorphism by the diorite-granodiorite-granite masses, producing rocks belonging to the hornblende hornfels facies. Many narrow lenticular quartz veins with erratic native Au content have been prospected. Minor Cu showings are found in the marginal diorite of the Revell granodiorite mass. The appendix describes molybdenite showings in Echo township in a granodiorite-granite pegmatite-aplite-quartz complex. The molybdenite is found in all 4 rock types but is most abundant in aplite, as disseminated flakes or in fracture fillings.--Auth.

**3-432.** Sanborn, Albert F. **GEOLOGY AND PALEONTOLOGY OF THE SOUTHWEST QUARTER OF THE BIG BEND QUADRANGLE, SHASTA COUNTY, CALIFORNIA:** California, Div. Mines, Spec. Rept. 63, 26 p., 12 illus., 2 maps, chart, 2 secs., 2 pls. incl. map, secs. (in pocket), 1960, 30 refs.

The area covered by this report is in the vicinity of the town of Big Bend. This region, which has been geologically unknown, contains sedimentary and volcanic strata of Mesozoic and Cenozoic ages.

The Mesozoic deposits are composed of pyroclastic rocks, lava flows, tuffaceous sandstone, argillite, and limestone. The Mesozoic formations, from the oldest to the youngest, are the Pit formation of Middle and Late Triassic age; the Hosselkus limestone, the Brock shale, and the Modin formation of Late Triassic age; the Arvison formation of Early Jurassic age; and the Bagley andesite and Potem formation of Early and Middle Jurassic age. Of the 7 formations mapped, 6 are continuations of formations found in the contiguous Redding quadrangle. These formations, which have been only briefly described by other authors, were studied in detail in the field and laboratory.

The Modin formation is redefined and divided into 3 members, the lower or Hawkins Creek member, the middle or Devils Canyon member, and the upper or Kosk member. This division is based on lithologic differences observed in the field. This formation has previously been considered Early Jurassic. However, newly discovered fossils from the formation include the species Spiriferina suessi Winkler and Choristoceras marshi Hauer which are restricted to the uppermost Triassic of Europe. Thus, the Modin formation is Triassic rather than Jurassic. Marine strata of this stage of the Triassic have not been reported previously from California.

A new name, the Arvison formation, is proposed for strata of Early Jurassic age, which unconformably overlie the Modin formation and conformably underlie the Potem formation. This formation contains the ammonite genera Arnioceras and Asteroceras, which indicate a Sinemurian (Early Jurassic) age.

The Cenozoic rocks consist of fluviatile deposits of Eocene age, which unconformably overlie the Mesozoic strata and are capped by lavas and pyroclastic rocks associated with the Pliocene Cascade lavas.--Auth.

**3-433.** Marsh, Owen T. **GEOLOGY OF THE ORCHARD PEAK AREA, CALIFORNIA:** California, Div. Mines, Spec. Rept. 62, 42 p., 11 illus., 3 maps (1 in pocket), 2 charts, 15 secs. (5 on 1 sheet in pocket), 1960, 37 refs.

The Orchard Peak area includes 70 sq. mi. at the southern end of the Diablo Range and lies principally in northwestern Kern County. The area is situated between the San Joaquin Valley on the NE. and the Temblor Range on the SW.

Rocks in the area range in age from Late Jurassic(?) to late Miocene. More than 26,500 ft. of marine sedimentary rocks are exposed, including about 6,300 ft. of Eocene and Miocene beds, at least 16,500 ft. of Upper Cretaceous, and about 3,700 ft. of Lower Cretaceous(?) strata. The Eocene and Miocene beds are part of a transgressive marine overlap of Tertiary upon Cretaceous strata. Seven new Cretaceous formations are recognized and named. These are, in ascending order: the Badger shale, Risco formation, Johnson Peak formation, Aguila sandstone, Serpiente sandstone, Moonlight formation, and Red Man sandstone. In addition, an impressive but unmeasurable thickness of Upper Jurassic(?) shales (herein named the Hex formation) crop out, forming the core of a diapir fold. Large amounts of serpentine and other Franciscan-type rocks lie in fault contact with the Mesozoic and Tertiary strata.

Striking facies changes are characteristic of the Cretaceous formations. Fossils are very scare or absent throughout most of the Cretaceous section, but locally they become abundant in the uppermost units where they include cephalopods, pelecypods, gastropods, hydrocorals, and foraminifers.

The Orchard Peak area, situated only 4 mi. from the San Andreas rift, is one of the most complexly deformed Cretaceous terranes in California. Most of the mapped area comprises the upper plate of the Antelope Valley thrust which has moved at least 6 1/2 mi. southward, bringing Cretaceous rocks to rest upon Miocene strata. This upper plate has been broken by a second important fault, the Aido Spring thrust, which has brought Lower Cretaceous(?) beds to rest upon rocks of late Late Cretaceous age, producing a stratigraphic separation of nearly 3 mi. Serpentine has been intruded in a cold state along both thrust surfaces. Several lesser thrust faults cut the upper plate of the Antelope Valley thrust, forming an imbricate pattern. In addition to the southward-moving thrusts just mentioned, there are 2 thrusts in which movement was probably toward the W. or SW. Numerous right-lateral tear faults developed during the thrusting; one of these, the Polonio Pass fault, has a displacement of more than 5,000 ft. Two piercement anticlines occur within the mapped area, one with a core of serpentine, the other with a core of bentonitic clays containing belemnites of Late Jurassic(?) and Early Cretaceous age. Three of the 6 synclines in the area contain Eocene rocks which rest unconformably upon Cretaceous beds.

The deformation in the area is at least post-late Miocene, probably late Pliocene or early Pleistocene. Other workers have suggested that the San Andres rift may have been caused by regional N.-S. compression. The writer believes that most of the structural features of the Orchard Peak area are likewise the result of N.-S. compression, although there is some indication that there was a later reorientation of the compression, at least locally, to produce the W.- or southwestward-moving thrusts.

The Cretaceous sediments were apparently derived from several different sources, though probably in large part from the ancestral Sierra Nevada, and were deposited in a shallow sea whose bottom subsided in the manner of a geosyncline. Nearby land areas must have been well forested.

Petroleum prospects in the Orchard Peak area seem moderately good. The impermeable sole of the Antelope Valley thrust could trap petroleum in the Miocene beds of the lower plate, providing that structural and stratigraphic conditions in the lower plate were favorable. Several producing oil fields are situated close to the mapped area. Other products of possible economic interest include drilling mud and water.--Auth.

3-434. Peck, Dallas L. GEOLOGIC RECONNAISSANCE OF THE WESTERN CASCADES IN OREGON NORTH OF LATITUDE 43 DEGREES: U.S. Geol. Survey, Repts., Open-File Ser. no. 565, 232 p., 38 figs. incl. 10 illus., 16 maps (1 in pocket), charts, secs. (in pocket), diags., graphs, 16 tables (7 in pocket), Apr. 1960, 162 refs.

A description of the stratigraphy and structure of the volcanic rocks of the central and northern parts of the western Cascades of Oregon. The map-area includes about 7,500 sq. mi. situated along the densely forested western slope of the Cascade range. It is bounded approximately by 43°N. and 45°30'N. on the S. and N., the crest of the range on the E., and 123° W. and the edge of the Willamette Valley on the W.

The volcanic Cascade Range comprises 2 physiographic subdivisions; the western Cascades, which include the wide deeply dissected western slope of the range, and the high Cascades, which include the relatively undissected crest of the range. The volcanic rocks of the western Cascades consist of deformed and partially altered continental flows and pyroclastic rocks, the age of which range from late Eocene to late Miocene, as determined chiefly from fossil plants from more than 50 localities. The volcanic rocks overlie or interfinger westward with marine sedimentary rocks, and in the southwestern part of the map area overlie pre-Tertiary plutonic and metamorphic rocks of the Klamath Mountain province.

Formations of Eocene age are exposed along the foothills of the Cascade Range S. of Eugene. They include the marine Umpqua, Tyee, and Spencer formations. The overlying Little Butte volcanic series of Oligocene and early Miocene age has an average thickness of 5,000 to 10,000 ft. Along the foothills N. of Cottage Grove, strata of the Little Butte interfinger with marine sandstone and tuff of middle Oligocene age (Eugene formation) and late Oligocene and early Miocene age (Scappoose formation). Middle Miocene Columbia River basalt unconformably overlies these strata in northern Oregon. The overlying Sardine formation of middle and upper Miocene age, which averages 3,000 ft. thick, consists chiefly of flows and tuff breccia of andesite. In the Portland basin the Sardine formation is overlain unconformably by more than 1,000 ft. of fluviatile conglomerate, sandstone, and siltstone of the Pliocene Troutdale formation. The overlying Boring lava and the volcanic rocks of the high Cascades consist mostly of unaltered and undeformed Pliocene and Quaternary flows of porous-textured nonporphyritic gray olivine andesite and olivine basalt.

The volcanic rocks of the western Cascades are cut by small intrusive bodies that range in composition from rhyodacite to basalt. The intrusive rocks probably fill magma chambers, conduits, and vents that fed the volcanic rocks. The medium-grained intrusive bodies are bordered by contact-metamorphic aureoles of dark flinty hornfels and are surrounded by more extensive areas of propylitically altered rocks. In the western Cascades of Oregon, dioritic and granitic intrusives, areas of propylitic alteration, and metalliferous deposits are mostly limited to a narrow northward-trending belt. Throughout most of the western Cascades pyroclastic rocks are devitrified to fine-grained aggregates consisting chiefly of zeolite (clinoptilolite or mordenite) or alkalic feldspar, cristobalite or chalcedonic quartz or opal, and montmorillonitic clay.

The volcanic rocks of the Cascade Range in Oregon form an elongate northward-trending downwarp. In northern Oregon the structure of the western Cascades is dominated by 4 northeastward-trending folds - the Breitenbush, Mehama, and Clackamas anticlines, and the Sardine syncline. Farther S. in the western Cascades the easterly dip of the rocks is reversed only locally by small folds; here northwestward-trending nearly vertical faults appear to be the major structural feature.

The mineral deposits of the western Cascades include Au- and Ag-bearing base metal sulfide, Hg, high-alumina clay, crushed rock, sand and gravel, ferruginous bauxite, agricultural lime, coal, silica, and dimension stone. The total recorded production of Au, Ag, Cu, Pb, and Zn from the map area has the value of $1,400,000.

The calc-alkaline volcanic rocks of the western Cascades in Oregon have a total volume of about 25,000 cu. mi. and an average composition of silicic andesite or dacite. Andesite that has a silica content of about 56% is the most abundant rock type; rocks containing 63 to 68% silica are sparse, and rocks containing about 70% silica are moderately abundant. Most of the volcanic activity in the Cascade Range was apparently concentrated in northward-trending belts, which in general shifted progressively eastward during the Cenozoic.

Most of the volcanic rocks are thought to be derived from 4 or 5 successive andesitic magmas (or successive groups of similar magmas). However, most of the silicic rocks of the Little Butte volcanic series may well be derived from silicic magmas, which were formed by partial fusion of portions of the underlying crust. The andesitic magmas may have formed by fusion of the underlying sialic and simatic crust at times of greater crustal stress, although an origin from contaminated primary basaltic magmas is by no means ruled out. Crystal fractionation rather than progressive assimilation appears to have been the dominant process in producing a variety of rocks of different composition from each of the successive andesitic magmas.--From auth. summ.

3-435. Siple, George E. SOME GEOLOGIC AND HYDROLOGIC FACTORS AFFECTING LIMESTONE TERRANES OF TERTIARY AGE IN SOUTH CAROLINA: Southeastern Geology, v. 2, no. 1, p. 1-11, map, chart, Aug. 1960, 11 refs.

Each epoch of the Tertiary period was characterized by deposition of fossiliferous marl, limestone, or coquina in the South Carolina Coastal Plain. Limestone and marl of Paleocene age occur in the subsurface in southern Beaufort County. Limestone or marl is contained in each successively younger Tertiary formation in other sections of the Coastal Plain. These include the Santee limestone and Castle Hayne limestone of Eocene age, the Cooper marl of Oligocene or possibly Eocene age and unnamed limestone of Oligocene age, the Duplin marl of Miocene age, and the Waccamaw formation of Pliocene age. These deposits occur as thin but extensive, gently dipping beds which show some local warping.

Intensive sinkhole development typical of karst topography is uncommon over most of the limestone area, although in several areas, notably in northern Orangeburg County, the topography is characterized by numerous solution depressions typical of the doline type. Solution depressions and "Carolina Bays" mark the topography of other areas underlain by calcareous Tertiary deposits. The occurrence of the "Carolina Bay" is almost indigenous to those areas underlain by formations of middle Miocene to early Pliocene age, predominantly the Duplin marl. The present location of karst topography is controlled in part by the Coriolis force in areas adjacent to the major stream channels and by the thickness and permeability of overburden in the interstream areas.

The solubility of the limestone aquifer separates it from most other aquifers which are comparatively insoluble. Climatic and geochemical factors are considered of primary importance in the solution process. During parts of Oligocene and Miocene time, the Santee and Castle Hayne limestones and the Cooper marl were exposed to subaerial and subsurface erosion, which could have developed caverns and conduits in the rock similar to those typical of a karst region. After their deposition these formations at first stored and transmitted water under water-table conditions. Subsequent artesian conditions developed when the limestones were covered by clay, marl, and siliceous phosphate of Miocene or younger age.

Solution of limestone below the water table is recognized elsewhere but not confirmed at more than normal depths in this state. The porosity and permeability of limestones in the southern part of the state appear to be greater in the upper part of the formation.

The marls of Miocene and Pliocene age are considerably thinner and less permeable than the Eocene deposits and are of minor importance as aquifers. However, their terranes have distinctive geomorphic features which have substantial significance in the genesis of the "Carolina Bay."--Auth.

**3-436. Terriere, Robert T. GEOLOGY OF THE GROSVENOR QUADRANGLE, BROWN AND COLEMAN COUNTIES, TEXAS: U.S. Geol. Survey, Bull. 1096-A, 35 p., 2 maps (1 in pocket, scale 1:31,680), 2 secs. (in pocket), 5 diags., table, 1960, 18 refs.**

The Grosvenor quadrangle is underlain by Pennsylvanian and lower Permian sedimentary rocks that dip gently to the WNW. Isolated patches of Lower Cretaceous strata, dipping slightly to the SE., overlap the Pennsylvanian and Permian rocks. Quaternary alluvium and terrace deposits cover older rocks along stream valleys.

The Pennsylvanian rocks include the Canyon and Cisco groups; the Wichita group represents the Permian system. The position of the systemic boundary is believed to be in the Waldrip shale member of the Pueblo formation near the base of the Wichita group but is drawn at the base of the Waldrip for practical purposes.

The Pennsylvanian and Permian rocks consist mainly of gray shale but also contain limestone, siltstone, sandstone, conglomerate, and red shale. Most of the sandstone and conglomerate occupy broad shallow channels cut during Pennsylvanian and early Permian time. Shale and siltstone also fill parts of some channels.

The Canyon group contains thicker limestone units and a larger proportion of limestone than do the Cisco and Wichita groups. Only one channel-fill deposit was found in the Canyon group within the quadrangle, although 2 other local channels have been reported in nearby areas.

The Cisco and Wichita groups contain many channel deposits. These are especially numerous in the lower part of the Wichita group. Three or more of these channel deposits are superimposed on one another and can be differentiated only by detailed study of their relationship to limestone beds. Within some of these main channels are smaller channels that seem to be the result of local cut and fill.

The Cretaceous rocks of the quadrangle consist of conglomerate, sandstone, siltstone, and shale. Sandstone is the most abundant and in many parts of the area has weathered to a blanket of loose sand.

Quaternary deposits consist of alluvium and scattered patches of terrace gravel along the main streams. The alluvium typically forms low-level terraces that have been incised recently and contain abandoned meanders and oxbow lakes. Remnants of higher terraces, covered with gravel, are several tens of feet above the present stream levels.

Large amounts of oil and gas have been produced in the Grosvenor quadrangle. Most of the oil and gas produced have come from lenticular sandstone beds in the Canyon group and the underlying Strawn group, but similar beds in the Cisco group produce oil W. and N. of the quadrangle. These oil-producing sandstones in the Cisco group resemble channel-fill deposits described in this report and appear to be their subsurface equivalents.--Auth.

**3-437. Mullens, Thomas E. GEOLOGY OF THE CLAY HILLS AREA, SAN JUAN COUNTY, UTAH: U.S. Geol. Survey, Bull. 1087-H, p. 259-336, 3 maps (1 in pocket, scale 1:62,500), 1960, 38 refs.**

The Clay Hills area includes 296 sq. mi. of canyon and plateau country in southwestern San Juan County. Rocks exposed in the area were mostly deposited in a terrestrial environment and are of Permian, Triassic, Jurassic, and Quaternary ages. The aggregate thickness of these rocks is about 3,900 ft.

The Cutler formation of Permian age is the oldest exposed formation and is subdivided into 3 red-bed tongues and 2 light-colored, wind-deposited, sandstone members - the Halgaito tongue, only partly exposed in the eastern part of the map area in the San Juan River canyon; the Cedar Mesa sandstone member, about 700 ft. thick; the Organ Rock tongue, about 350 ft. thick; the De Chelly sandstone member, about 30 ft. in the southwestern part of the area and absent elsewhere because of nondeposition; and the Hoskinnini tongue, about 110 ft. thick in most of the area, but only 42 ft. thick where it overlies the De Chelly sandstone member.

The Moenkopi formation of Early and Middle(?) Triassic age conformably overlies the Cutler formation, ranging in thickness from 260 to 340 ft. It is composed of a lower evenly bedded siltstone, a middle cross-laminated sandstone, and an upper evenly bedded siltstone. The Moenkopi is overlain unconformably by the Chinle formation of Late Triassic age.

The Chinle formation of Late Triassic age ranges from 780 to 1,195 ft. in thickness and is composed of sandstone, conglomerate, mudstone, variegated claystone, limestone, and calcareous siltstone. The Chinle can be subdivided into 4 divisions based on the dominance of rock types, but gradation and intermixing of rock types make it difficult to map the upper 3 divisions. Therefore, the Chinle is divided into the Shinarump member (lower unit) and undifferentiated Chinle (upper unit).

The Shinarump member, the lower member of the Chinle formation, consists of cross-laminated sandstone and conglomerate irregularly interbedded with mudstone. It is conspicuous only in the southern part of the map area where it reaches a thickness of 176 ft. Elsewhere the Shinarump is absent or represented only by thin lenses; the local absence is due to nondeposition. The Shinarump member, where present, conformably underlies the undifferentiated Chinle formation.

The undifferentiated Chinle formation can be divided into a lower unit of sandstone and mudstone; a middle unit of variegated claystone, calcareous siltstone, and limestone; and an upper unit of reddish-orange to reddish-brown interbedded siltstone and very fine-grained sandstone. All contacts between units of the undifferentiated Chinle are conformable, and the upper unit conformably underlies the Glen Canyon group.

The formations of the Glen Canyon group include the Wingate sandstone of Late Triassic age, the Kayenta formation of Jurassic(?) age, and the Navajo sandstone of Jurassic and Jurassic(?) age. The Wingate is a massive wind-deposited sandstone and averages about 320 ft. thick; the Kayenta consists of irregularly bedded fluviatile deposits and averages about 220 ft. thick; the Navajo is a massive wind-deposited sandstone that includes lenses of limestone. A complete thickness of the Navajo cannot be measured in the map area as erosion during Cenozoic time has removed the upper part of the sandstone; the maximum preserved thickness is about 600 ft.

Deposits of Quaternary age, consisting of landslide blocks, terrace deposits, alluvium in present flood plains, fans, and dune sand, are widespread in the map area.

The Clay Hills area is on the gently dipping W. flank of the Monument upwarp. Locally the westward dip is interrupted by minor northward-trending asymmetrical folds. Normal faults are associated with the eastward-dipping limbs of the minor folds; many joints cut the sandstone strata.

Interest in the mineral resources of the Clay Hills area has centered around U, Au, and Cu. To the present time no commerically important mineral deposit has been discovered in the area, although much time and effort has been used in prospecting for U.--Auth.

3-438. Tateiwa, Iwao. **OUTLINE OF THE GEOLOGY OF KOREA.** Translated by the author: Internat. Geology Rev., v. 2, no. 12, p. 1053-1070, 2 tables, Dec. 1960, 24 refs.

This paper gives a general idea of the sequence of geological events to which Korea was subjected. Following the introduction, the following sections are included: comparison with Japan; comparison with S. Manchuria and N. China, with special reference to Precambrian stratigraphy in Korea; Precambrian granites in Korea; and synopsis of the geological system of Korea.

3-439. Weihaupt, John G. **RECONNAISSANCE OF A NEWLY DISCOVERED AREA OF MOUNTAINS IN ANTARCTICA:** Jour. Geology, v. 68, no. 6, p. 669-673, 3 illus., 2 maps, Nov. 1960, 2 refs.

A general description of the geology and geography of a newly discovered range of mountains (approx. 72°15' S.-160°E.) is given along with their location and extent.--Auth.

## 2. GEOMORPHOLOGY

See also: Geologic Maps 3-369, 3-415; Areal and Regional Geology 3-435; Paleontology 3-485, 3-495.

3-440. Shchukin, I.S. **THE PLACE OF GEOMORPHOLOGY IN THE SYSTEM OF NATURAL SCIENCES AND ITS RELATIONSHIPS WITH INTEGRATED PHYSICAL GEOGRAPHY:** Soviet Geography, v. 1, no. 9, p. 35-43, Nov. 1960.

The geologists' claim to geomorphology as a purely geological science is unjustified. Geomorphology is a branch of integrated physical geography concerned with the study on a broad geographic plane of one component of the natural environment, its relief. It can therefore be assigned with complete justification to the group of geographic sciences.--M. Russell.

3-441. Zekkel, Ya. D. **ON THE COURSES OF DEVELOPMENT AND THE NEXT TASKS OF GEOMORPHOLOGY:** Soviet Geography, v. 1, no. 1/2, p. 28-33, Jan.-Feb. 1960, 31 refs.

Early support for the theory that the origin of relief on plains is primarily the result of exogenic forces, exemplified by the preoccupation of many geomorphologists with Quaternary analysis, has more recently been countered by support for theories of tectonic origin or endogenic forces. Unfortunately the 2 schools of thought are developing too independently instead of attempting to recognize interrelationships. Geomorphology is a geographic science, in spite of its reliance on geologic data, because it studies one of the components of the geographic landscape, the present structure.--M. Russell.

3-442. Spiridonov, A.I. **GEOMORPHIC MAPPING ABROAD:** Soviet Geography, v. 1, no. 9, p. 61-67, Nov. 1960, 22 refs.

Geomorphic maps produced in, or of, France, Belgium, Czechoslovakia, Switzerland, Japan, and several central and southern African areas, are described and evaluated. Scales, coloring, symbols, and features emphasized by the several mapping systems are compared. The point is made that the smaller the map scale and the greater the territory covered, the better are large geomorphic features identified on maps.--M. Russell.

3-443. LeGrand, Harry E. **METAPHOR IN GEOMORPHIC EXPRESSION:** Jour. Geology, v. 68, no. 5, p. 576-579, Sept. 1960, 7 refs.

Differences in concepts of many geomorphic processes are attributed in part to the widespread use of metaphor, which encourages superficial perception and faulty interpretations. Some terms, such as "slope retreat," seem to animate the landscape and to muddle our inferences. By recognizing the expediency of metaphor and its indelible place in our language and by trying to discipline our thoughts, we might escape the illusion that we adequately understand geomorphic processes.--Auth.

3-444. Dorf, Erling. **CLIMATIC CHANGES OF THE PAST AND PRESENT:** Am. Scientist, v. 48, no. 3, p. 341-364, 2 illus., 8 maps, chart, graph, Sept. 1960, 64 refs.

Paleobotanist Erling Dorf marshals the evidence for climatic fluctuation during the past 40 million years, maps the changing climatic zones of North America, and takes a tentative look at the future. Ancient climates have been reconstructed by studies of fossil plant assemblages, corroborated by animal fossils and rocks.

Tertiary climatic conditions of North America were generally warmer than at present. During late Eocene-early Oligocene time the climate was notably warmer than now; the tropical forest belt extended 10 to 12° farther N. and the temperate forest belt was 20° farther N. In late Oligocene-early Miocene the climate cooled, as indicated by southward recession of tropical and subtropical vegetation. By middle to late Miocene epoch the fossil record shows a slight reversal of the forest migrations. However, by the end of Miocene time the climate again began cooling. Fossil records from the late Pliocene show forest distribution approaching that of the present.

In western Europe the fossil record of both plants and animals indicate essentially the same climatic trend; from tropical conditions during Eocene to cooler climate at the end of Pliocene. The mean annual temperature of the region is estimated to have dropped about 15° in that time.

The cooling trend which began in the Oligocene epoch led to widespread glacial activity in the Pleistocene. Recent studies suggest a major southward migration of the forests with fossil subarctic plants and animals being found far S. in North America. In western Europe subarctic conditions extended as far S. as the Mediterranean. During the interglacial stages the climates were somewhat warmer than today and rapid recession of the ice sheets and a northward shift of forests took place.

Pollen record shows a period of temperatures a little higher than present from about 5000 to 2000 B.C. This was followed by a period of general cooling until 500 B.C., when there was a reversal. Archeological records indicate that the last major warm episode, previous to present time, occurred about 1000 - 1300 A.D. Cooler conditions began about 1600 A.D., culminating in the "Little Ice Age" lasting from 1650 through 1850. This has been followed by a warming climate.

In summary the greater part of at least the past 500 million years has had a warm nonglacial climate as contrasted with the cool glacial conditions of the past million years. The earth at present appears to be in one of the slightly warmer interglacial stages with return to another glacial stage predicted in about 10,000 to 15,000 years. Though marked by minor colder and warmer cycles the general warming trend should continue for two or three hundred years over most of the lowland regions of the northern hemisphere.--T.H.W. Loomis.

**3-445. Allen, Clarence R., and others. STRUCTURE OF THE LOWER BLUE GLACIER, WASHINGTON: Jour. Geology, v. 68, no. 6, p. 601-625, 5 illus., 12 figs. incl. 4 maps, sec., diags., 2 tables, Nov. 1960, 41 refs.**

Structural features studied in lower Blue Glacier are the foliation pattern, an unusual longitudinal septum, ogives, crevasses, and related ice fabrics. A 300-m. icefall separating the major accumulation basins from the ice tongue plays a dominant role in the formation of the principal foliated structures. Three types of ice are involved; coarse-bubbly ice, coarse-clear ice, and fine ice. Most and perhaps all the fine ice represents partly recrystallized insets or infolds of firn.

An angular unconformity between stratified firn and well-foliated glacier ice is attributed to a period of high firn limits prior to 1948 and lower firn limits since.

Below the firn edge the glacier displays a foliation pattern of 2 sets of nested arcs, convex down-glacier. These are separated by a narrow zone of strongly foliated, structurally complex ice termed the longitudinal septum. The foliation pattern becomes more irregular toward the terminus because of intersecting folia and discontinuities in strike.

The ogives of the Blue Glacier appear on the surface as alternating dark and white bands conformable with the arc-shaped foliation. The dark bands are underlain by well-foliated, heterogeneous material featuring unusually large proportions of fine and coarse-clear ice. The white bands are underlain by relatively massive, uniform coarse-bubbly ice.

It is inferred that the transverse foliation pattern originates in a zone of strong compressive flow immediately below the icefall. Transverse inhomogeneities created within the fall may be an important initial factor. Once formed, the foliation passively undergoes deformation within the ice tongue as it flows down the valley. The arc-shaped pattern develops within a short distance below the fall owing to differential flow. A calculation based on borehole data shows that deformation within the glacier during flow is of the correct magnitude to account for the dip of the foliation as observed at the apexes of the nested arcs, assuming that the initial attitude at the base of the icefall is essentially vertical. Complications appearing in the foliation pattern in the lower reaches of the glacier are attributed chiefly to topographic irregularities on the glacier floor, near and below the base of the icefall.

It is postulated that the longitudinal septum is formed at the base of the icefall where 2 ice streams, split by a large rock bastion, reunite. Differences in direction and velocity of flow at the junction result in strong compression and shear which produce the intense foliation of the septum. The high content of fine ice is attributed to the insetting and infolding of firn within the icefall and in a fosse at its base.

The ogives are inferred to be primarily features formed within the icefall but subsequently modified in the zone of compressive flow at its base. The ogive dark bands may represent greatly compressed and partly recrystallized ice breccias which accumulated within crevasses formed at the lip of the icefall. There is no compelling evidence that the Blue Glacier ogives are annual features.--Auth.

**3-446. Rukhin, L.B. PROBLEM OF THE ORIGIN OF CONTINENTAL GLACIATION. Translated by E. Rukhina: Internat. Geology Rev., v. 2, no. 11, p. 925-935, 3 maps, Nov. 1960, 27 refs.**

Changes in the flow of the Gulf Stream at the end of the Tertiary producing increased precipitation in Arctic areas, combined with the appearance of the Thompson ridge cutting off warm North Atlantic waters from the Arctic basin, were contributing factors to the first of the Pleistocene glaciations. Periodic opening and closing of the barrier to warm waters during the Pleistocene explain the interglacial epochs. Continental glaciation begins at the periphery of land masses where precipitation is greatest, not in the high interiors. A greater factor determining continental glaciation is polar wandering. During the Tertiary the North Pole was in the Pacific Ocean where the water is so deep that freeze-over could not occur. Evidence from paleomagnetic studies, paleontology, and stratigraphy shows that upper Paleozoic glaciation was similarly the result of a combination of physico-geographic factors resulting from polar wandering and not continental drift.--M. Russell.

3-447. Goldsmith, Richard. A POST-HARBOR HILL-CHARLESTOWN MORAINE IN SOUTHEASTERN CONNECTICUT: Am. Jour. Sci., v. 258, no. 10, p. 740-743, 2 illus., 2 maps, Dec. 1960, 7 refs.

A discontinuous, NE.-trending belt, at least 13 mi. long, of linear accumulations of boulders and patches of hummocky till at which outwash deposits head, lies about 8 mi. N. of Long Island Sound near New London, Connecticut. This feature, here named the Ledyard moraine, marks a temporary halt during ice retreat from the moraines of Wisconsin age of Long Island and southern Rhode Island. It lies S. of the postulated line of the Middletown readvance.--Auth.

3-448. Leighton, Morris M. THE CLASSIFICATION OF THE WISCONSIN GLACIAL STAGE OF NORTH CENTRAL UNITED STATES: Jour. Geology, v. 68, no. 5, p. 529-552, 4 illus., 4 maps, 2 secs., 2 graphs, 4 tables, Sept. 1960, 54 refs.

The Wisconsin glacial stage is classified on the basis of stratigraphy into 6 glacial substages, named, from older to younger, Farmdale, Iowan, Tazewell, Cary, Mankato, and Valders.

In this paper names are proposed for the intraglacial substages not previously designated, completing the sequence as follows:

| Stage | Substage |
|---|---|
| Recent | ......................... |
| Wisconsin ..... | Valders (glacial) |
| | Two Creeks (intraglacial) |
| | Mankato (glacial) |
| | Bowmanville (intraglacial) |
| | Cary (glacial) |
| | St. Charles (intraglacial) |
| | Tazewell (glacial) |
| | Gardena (intraglacial) |
| | Iowan (glacial) |
| | Farm Creek (intraglacial) |
| | Farmdale (glacial) |

These divisions fit the natural succession and provide the basis for historical and climatic interpretations of a broad scope, be they glacial advances, pauses, retreats, stagnation, eustatic changes of sea level, events beyond the ice sheet, changes of biotas, climatic changes and climatic controls, and analysis of radiocarbon dating.

Valley trains were deposited during active maximum and submaximum stands of the glaciers and were in part followed by glacial torrents. The latter occurred when the icecap was being reduced and sea level was being raised. Except in the case of the Valders, another refrigeration followed, but the climatic change that halted the advance of the Valders was revolutionary. It brought on progressive stagnation and initiated the Recent about 11,000 radiocarbon years ago.

This paper also gives consideration to other classifications including the one recently proposed by Frye and Willman's new classification.--Auth.

3-449. White, George W. CLASSIFICATION OF WISCONSIN GLACIAL DEPOSITS IN NORTHEASTERN OHIO: U.S. Geol. Survey, Bull. 1121-A, 12 p., map, table, 1960, 23 refs.

Wisconsin glacial deposits in northeastern Ohio are divided into several distinctive rock-stratigraphic units, each of which extends hundreds or thousands of square miles in the surface and subsurface. All units can be traced eastward into Pennsylvania. The sandy Mogadore till of Tazewell age crops out near Akron and extends beneath later tills northward in Ohio and eastward into Pennsylvania. All the other units are of Cary age. The silty, sandy Kent till of early Cary age crops out in a large area around the margin of the Grand River lobe and occurs below later till in the central part of the lobe; it extends eastward into Pennsylvania. The Lavery till crops out in a belt as much as 2 mi. wide in northern Trumbull and southeastern Ashtabula counties and the belt widens considerably to the E. in Pennsylvania. In Ohio the Lavery till is mainly a subsurface unit. The Windham sand is the outwash equivalent of the Lavery till. The clayey Hiram till of late Cary age is the surface material in the central part of the area formerly covered by the Grand River lobe and extends far westward into the area of the Erie lobe. The Ashtabula till of latest Cary age is the surface material near Lake Erie; it extends across Pennsylvania into New York.--Auth.

3-450. Lockwood, W.N., and Harold Meisler. ILLINOIAN OUTWASH IN SOUTHEASTERN PENNSYLVANIA: U.S. Geol. Survey, Bull. 1121-B, 9 p., 4 illus., map, table, 1960, 7 refs.

The most complete exposed section of Pleistocene sediments in the coastal plain of Pennsylvania is in the Turkey Hill gravel pit in southeastern Bucks County. The section consists of highly weathered sand and gravel outwash, containing a red zone in its upper part, and is believed to be of Illinoian age. A lag gravel capping the outwash and containing ventifacts records periglacial conditions. Loess overlies the lag gravel. Relatively unweathered Wisconsin outwash overlies the Illinoian outwash on the flanks of Turkey Hill.--Auth.

3-451. Heusser, Calvin J. LATE-PLEISTOCENE ENVIRONMENTS OF THE LAGUNA DE SAN RAFAEL AREA, CHILE: Geog. Rev., v. 50, no. 4, p. 555-577, 7 illus., map, profiles, Oct. 1960, refs.

The American Geographical Society Southern Chile Expedition 1959 studied the glacial, climatic, and vegetational changes in the Laguna de San Rafael area (46°40'S., 74°00'W.) for the purpose of constructing a late-Pleistocene chronology of events for comparison with chronologies from the Northern Hemisphere. The regional glacial geology, palynology, and vegetation were investigated, along with the determination of the ages of several modern moraines formed by San Rafael glacier. Radiocarbon dates supplement these ages.

The laguna was not occupied by San Rafael glacier ca. 6850 B.P. (Before Present), but an important advance of the glacier occurred ca. 5000 B.P. This advance resulted in the formation of Témpanos I and II moraines which comprise the laguna's rim. Recession from Témpanos I is ca. 4000 B.P. Correlatives of these moraines appear to be those built by Guala glacier, N. of the laguna. At the time of the earliest observations by de Vea in 1675 the glacier had withdrawn from the laguna. Sometime after this, but before Garcia's visit in 1766, the glacier had a strong advance. Recession from the modern terminal moraine is dated ca. 1882, from the next major moraine ca. 1910, and is rapid between 1910 and 1940. After 1940 the change in position is small and in 1958 the glacier was advancing over ground ice-free since the 1920's. Regional palynology favors a warm, dry climate beginning ca. 6500 B.P., interrupted by a moist phase which resulted in

Témpanos glaciation. Climate more recently has become cool and more humid.

In-phase hemispheric environmental relationships are suggested by these findings, although such a conclusion is still premature.--Auth.

**3-452.** Reiner, Ernst. THE GLACIATION OF MOUNT WILHELM, AUSTRALIAN NEW GUINEA: Geog. Rev., v. 50, no. 4, p. 491-503, 5 illus., 2 maps, 3 secs., table, Oct. 1960, refs.

The summit area of Mount Wilhelm (about 15,000 ft.) in Australian New Guinea lies above the treeline and bears evidence of a Pleistocene glaciation. The glacial landforms are moraines, which occur mainly to the W. of the divide that runs N.-S. over the summit.

One of the glacial valleys has been investigated in detail. There is a lateral moraine 200 ft. above the terminal moraine. Well-developed cirques are now occupied by lakes between 11,500 and 12,000 ft. above sea level, indicating the position of the Pleistocene snowline. Incipient cirques at higher levels are indicative of a stillstand during deglaciation or of a subsequent minor glacial readvance.

Frost occurs regularly in the summit region and may extend as far down as 8,000 ft. at Keglsugl (where at present weather observations are made), but snow falls only once or twice a year. Periglacial features are found in the alpine zone. By comparing the climatic data with those of other tropical areas, the present snowline is deduced to be at 15,400 ft., i.e., 500 ft. above the highest peak of Mount Wilhelm.

A comparison is made with landforms in neighboring areas such as the extinct volcanoes Mount Hagen and Mount Giluwe, where no glacial landforms but only periglacial features occur.

The present and past glaciation of Mount Carstenz in Netherlands New Guinea and the past glaciation of Mount Wilhelm are compared.--Auth.

**3-453.** Péwé, Troy L. MULTIPLE GLACIATION IN THE McMURDO SOUND REGION, ANTARCTICA - A PROGRESS REPORT: Jour. Geology, v. 68, no. 5, p. 498-514, 3 illus., 7 maps, graph, Sept. 1960, 19 refs.; also pub. as: Ohio State Univ., Research Foundation, RF Project 825, Rept. no. 2, pt. 9, Feb. 1960.

At least 4 major Quaternary glaciations, each successively less extensive than the former, are recorded in the McMurdo Sound region of Antarctica. Deposits of the earliest recognized glacial advance occur high on ridges and flat areas. The deposits are 2,000 ft. above the valley floor, are badly weathered, and have little or no morainal form. Ice of this glaciation filled all the valleys and must have filled McMurdo Sound to an elevation of 2,000 ft.

Deposits of the next 2 succeeding glaciations are distributed around the sound as well-preserved, but considerably subdued, moraines of both outlet and alpine glaciers. During the earlier of these 2 glaciations, alpine glaciers reached the expanded Koettlitz and Ferrar outlet glaciers. Outlet glaciers filled the southern part of McMurdo Sound to an elevation of about 1,000 ft. During the latter of these 2 advances many alpine glaciers did not reach the outlet glaciers.

The latest major glaciation is represented by well-preserved ice-cored moraines. Number and position of deltas in drained glacier-ice-blocked lakes suggest the possibility of 3 stillstands or minor advances during this glaciation. Radiocarbon dating of algae in drained ponds indicates a minimum age of 6,000 years for this glaciation.--Auth.

**3-454.** Lutz, H.J. MOVEMENT OF ROCKS BY UPROOTING OF FOREST TREES: Am. Jour. Sci., v. 258, no. 10, p. 752-756, 2 illus., Dec. 1960, 12 refs.

Boles of tall trees with large diameters behave as cantilever beams possessing great strength and the capacity for exerting tremendous leverage at the point of support or fulcrum. When trees are uprooted by wind they may move, both vertically and horizontally, rocks having a volume of as much as 50 cu. ft. and a weight of around 4 1/4 tons. Uprooting of trees contributes to downslope movement of the soil and rock mantle and locally may initiate erosion of the gully type. Some of the effects of soil and rock movement by uprooting trees are similar to those resulting from periglacial frost heaving.--Auth.

**3-455.** Heath, James P. REPEATED AVALANCHES AT CHAOS JUMBLES, LASSEN VOLCANIC NATIONAL PARK: Am. Jour. Sci., v. 258, no. 10, p. 744-751, illus., map, table, Dec. 1960, 4 refs.

The Chaos Jumbles is an avalanche deposit covering more than 2 sq. mi. At least 3 separate avalanches descended at intervals of many years from the volcanic domes of Chaos Crags. All 3 flows are surprisingly similar as to extent and direction.--Auth.

**3-456.** Carson, Charles E., and Keith M. Hussey. HYDRODYNAMICS IN THREE ARCTIC LAKES: Jour. Geology, v. 68, no. 6, p. 585-600, 9 illus., 9 figs. incl. 2 maps, diags., graph, 4 tables, Nov. 1960, 18 refs.

Currents generated in the lakes near Point Barrow, Alaska, by prevailing winds are described for 2 different situations: that in which there is an ice cake present, and that of open lakes. A hypothetical analysis is given for currents associated with ice cakes and a somewhat longer discussion, including a review of a previous hypothesis, follows the description of currents in open lakes. There is a brief account of basin features related to water motion and a description of differences in water temperature around the ice cakes.--Auth.

**3-457.** Sharp, W.E. THE MOVEMENT OF PLAYA SCRAPERS BY THE WIND: Jour. Geology, v. 68, no. 5, p. 567-572, 2 graphs, 2 tables, Sept. 1960, 8 refs.

A theoretical discussion shows that it is possible for the wind to move rocks over a wet playa surface provided a sufficiently high pore pressure exists beneath the rocks. Measurements were carried out to determine the pore pressure which could exist under a rock on a muddy surface. The ratio of pore pressure to total rock pressure gave a range of 0.34 to 0.64, which would correspond to wind velocities of 45 m./sec. (100 m.p.h.), to 33 m./sec. (75 m.p.h.) for rocks having a large frontal area to mass ratio of $20 \times 10^{-3}$ cm.$^2$/g.--Auth.

**3-458.** Cotton, C.A. LEVELING BY ROCK-FLOOR ROBBING IN BRAZIL: Jour. Geology, v.

**8, no. 5, p. 573-574, Sept. 1960, 8 refs.**

A process which Francis Ruellan believes to be ctively smoothing the land surface in those parts of razil that have strongly marked wet and dry seasons s scarcely distinguishable from the one described by V.M. Davis as "rock-floor robbing" by sheetfloods, nsofar as that process takes part in the degradation f pediments.--Auth.

**-459. Feder, Allen M. INTERPRETING NATURAL TERRAIN FROM RADAR DISPLAYS: Photoramm. Eng., v. 26, no. 4, p. 618-630, 20 figs. ncl. 9 illus., 2 maps, sec., 3 graphs, Sept. 1960, refs.**

Radar is demonstrated to be an effective means or acquiring terrain data. A significant capability n such application stems from radar providing its wn illumination. With control of the energy propagation factor, terrain information is to some effect utomatically interpreted by the electronic process eading to display.

The display content is strongly controlled by radar nergy's ability to penetrate terrain as well as to liscriminate among surface conditions. The penetraion data given and the related reradiation amplitudes vidence how subsurface composition and conditions, uch as moisture and metallic contents and temperature, can be determined by radar. Reradiation raphs are also used to demonstrate the derivation f information concerning the veneer on the terrain, uch as gravel sizes, and the water content of snow.

Some simple interpretations of PPI scope graphics re possible. AN/APQ-13 displays are interpreted eomorphologically. An AN/APQ-23 frame is interpreted for veneer textures and a sidelooking radar lisplay reveals stratigraphic data, land-use detail, nd offshore information.

An advantage of the former 2 radar types is hown in the area coverages possible per display hotograph (e.g., 2,700 sq. mi.) while automatically etaining some element of geographic control. The levelopment of high-resolution, sidelooking radar s tending toward geodetic-control accuracy but acrifices the extensive area coverage capability. Therefore trade-offs such as these, and dependence f display interpretation on data from other sources ndicate radar is a valuable complement to other ensors, not a substitute for them.--Auth.

**3-460. Tanner, William F. BASES FOR COASTAL CLASSIFICATION: Southeastern Geology, v. 2, no. 1, p. 13-22, table, Aug. 1960, 23 refs.**

A preliminary examination of 14 coastal classification schemes leads to a list of 17 types of basic nformation on which such schemes can be constructed. (Additional types of basic information may be added in the future). A chart of classificatory chemes shows the extent to which each worker has used, or ignored, the available types of information.

Several classifications, made or revised during he last 15 years, are outlined briefly. These include those of Shepard, Cotton, Fleming and Elliott, Valentin, Tanner, Price, and Guilcher.--Auth.

**3-461. Tanner, William F. 'PERCHED' BARRIER ISLANDS, EAST FLORIDA COAST: Southeastern Geology, v. 2, no. 2, p. 133-135, table, Nov. 1960.**

The ratio between lagoon width and barrier width is, typically, about 6, and rarely less than about 2.5. Along the E. coast of Florida, this ratio commonly falls in the interval, 0.5 to 2.0. This anomalous situation may be related to the unusual structure of E. coast barrier islands, which are "perched" on ridges of lithified bedrock.--Auth.

**3-462. Butzer, Karl W. ON THE PLEISTOCENE SHORE LINES OF ARABS' GULF, EGYPT: Jour. Geology, v. 68, no. 6, p. 626-637, map, 2 profiles, Nov. 1960, 21 refs.**

The accepted sequence of Pleistocene shorelines SW. of Alexandria, outlined by F.E. Zeuner and Shukri, Philip, and Said, is questioned and considered as misleading on the grounds of insufficient field evidence. Profiles drawn on the basis of the topographic maps employed by these authors show the impossibility of assigning reliable altimetric values to most of the former sea levels responsible for the offshore bar and lagoon topography. That which is actually known about the sequence of sea levels is discussed, the accepted warping or folding of the area is negated, and the occurrence of NW.-SE. fracture zones in the Maryut is proposed. Although there are several submerged shorelines, no evidence points toward a so-called "Epi-Monastirian" level of ± 0 m.--Auth.

**3-463. Henderson, E.P. SURFICIAL GEOLOGY OF STURGEON LAKE MAP-AREA, ALBERTA: Canada, Geol. Survey, Mem. 303, 108 p., 13 illus., 4 maps (3 in pocket, incl. Map 1077A, scale 1:253,440), secs., graph, 1959, 83 refs.**

The report deals with Pleistocene and Recent deposits and related topographic features, of 2,700 sq. mi. of the Peace River country, about 230 mi. NW. of Edmonton. Cordilleran ice from the Rocky Mountains to the W. never reached the area, although Cordilleran outwash did. Till sheets record 3 invasions by Laurentide glaciers, probably all Wisconsin age, and there is one deposit that is ascribed to a pre-Wisconsin glacier. Melting of the last ice was slow, with glacial wastage apparently taking place largely by evaporation; meltwater streams were small and glaciofluvial deposits are scarce.

As the Laurentide glaciers retreated down the regional slope to the NE. they dammed extensive proglacial lakes. These covered more than half the area, and their deposits mask the glacial materials and modify the topography. Beaches were poorly developed and fragmentary because of fluctuation in water levels, as alternate escape routes were opened or closed by the ice, and inhibition of wave action by ice-choked lake waters. Varved deposits indicate the lakes were shortlived. During deglaciation, large areas of these surface deposits were modified under a severe climate, and mounds of polygenetic origin were built. These cover many tens of square miles and form a distinct morphological unit. Parts of the mound fields were covered with lacustrine materials when late ice readvance reconstituted lower phases of the proglacial lakes. Subsequently large areas of sand and silt dunes were formed by westerly winds before vegetation stabilized the dunes. Thin silt covers the ground moraine in some districts. This was deposited as loess E. of outwash and lake deposits, or laid down by sheet wash below outwash fans or in slackwater in low areas.--Auth.

# 3. STRUCTURAL GEOLOGY

See also: Geophysics 3-521, 3-522; Igneous and Metamorphic Petrology 3-594.

**3-464.** Hughes, R.J., Jr. A DERIVATION OF EARLE'S FORMULA FOR THE CALCULATION OF TRUE DIP: Southeastern Geology, v. 2, no. 1, p. 43-48, 2 figs., Aug. 1960, ref.

A useful formula for true dip calculation has special value for areas of low dip such as the coastal plains where solutions by descriptive geometry or by graphical methods may be awkward. A minor error is corrected in the derivation of the formula. --Auth.

**3-465.** CREEP ON THE SAN ANDREAS FAULT. **Three related articles by 1) Karl V. Steinbrugge and Edwin G. Zacher, 2) Don Tocher, and 3) Charles A. Whitten and C.N. Claire: Seismol. Soc. America, Bull., v. 50, no. 3, p. 389-415, 5 illus., maps, diags., graphs, 4 tables, July 1960, 17 refs.**

Progressive destruction of buildings and other works of man at the W.A. Taylor Winery near Hollister, California, indicates that one side of a segment of the San Andreas fault is creeping relative to the other. Three different types of measurements all yield an annual rate of creep of approximately 1/2 in. per year.

1) Steinbrugge and Zacher. Fault Creep and Property Damage: Measurements of the separations of pairs of reference marks adjacent to the line of creep have been repeated periodically since 1956, and damage to structures provides a good measure of the total creep since 1948. Reports of damage to older buildings on the same site suggest that the creep may have been going on at about the present rate for 50 or more years.

2) Tocher. Creep Rate and Related Measurements at Vineyard, California: Creep recorders designed to measure continuously the differential lateral movement of adjacent sections of the concrete floor have been installed in the main winery building. The creep rate so determined has been about 1/2 in. per year (with right-lateral sense) for the past 2 years. Creep accumulates largely in spasms of rather short duration (on the order of a week) separated by intervals of weeks or months during which little or no creep takes place. Ninety-two percent of the movement in a recent 371-day period accumulated in 4 spasms of total duration 34 days. Three of these spasms began at times when no local earthquakes were recorded on near-by seismographs; the fourth began with a sudden right-lateral fault movement of 3 mm. at the time of a sharp local earthquake (Richter magnitude 5.0) on Jan. 20, 1960 (GCT).

3) Whitten and Claire. Analysis of Geodetic Measurements along the San Andreas Fault: Resurveys over monumented points established near the winery also yield a rate of slippage or creep along the fault line of 1/2 in. per year. A new method for analyzing the data obtained by retriangulating over monumented points at wide intervals (10 to 20 years) is presented and applied to 2 triangulation networks which cross the San Andreas fault in central California. Results from a net near Hollister show an average creep rate of about 1/2 in. per year; results from a net near Cholame (about 75 mi. SE. of Hollister) show an average creep rate of about 1/10 in. per year. The results also give an angular value which represents the deformation in the crust adjacent to the fault line.--Auth.

**3-466.** Hall, Clarence A., Jr. DISPLACED MIOCENE MOLLUSCAN PROVINCES ALONG THE SAN ANDREAS FAULT, CALIFORNIA: **California, Univ., Pubs. Geol. Sci., v. 34, no. 6, p. 281-308, 3 maps (in pocket), chart (in pocket), 8 tables, 1960, 98 refs.**

Assuming that present-day temperature and other ecologic requirements for molluscan genera and species are generally the same for most taxa that lived in the past, and that organisms are critically limited in distribution by minimum temperatures, then some thermal limits may be inferred for the late Miocene molluscan faunas in the Coast Ranges of California. By plotting the present positions of late Miocene paleo-molluscan provinces and isotherms, provincial and temperature differences are revealed on opposite sides of the San Andreas fault. Right-lateral slip displacement of latitudinal provincial boundaries is approximately 120 mi.

Because of the subjectivity of locating the late Miocene molluscan provinces and isotherms, this means of measuring the amount of slip along the San Andreas fault gives only an approximate order of magnitude; the minimum is 50 mi. and the maximum is 150 mi.--Auth.

**3-467.** Richard, B.H. CONJUGATE QUARTZ VEINS IN THE LYNCHBURG GNEISS NEAR FANCY GAP, CARROLL COUNTY, VIRGINIA: **Southeastern Geology, v. 2, no. 2, p. 127-132, illus., diags., Nov. 1960, ref.**

Three sets of joints occur near Fancy Gap. Two of these sets, which constitute a conjugate set of shear fractures, have been filled with quartz. That all joints cut the gneissosity of the Lynchburg gneiss shows clearly that the joints developed after the rock was metamorphosed. The joints formed in 3 stages: 1) a set of nearly vertical shear joints that strike N. 55°E. developed and was filled with quartz; 2) a set of nearly vertical shear joints that strike N. 75°W. developed, locally displaced the first set, and was filled with quartz; 3) another set of joints was formed and displaced the second set with movement essentially parallel to the plane of the first set. The gneiss was deformed plastically subsequent to all jointing, and this resulted in the filling of all voids.--Auth.

**3-468.** Charters, A.C. HIGH-SPEED IMPACT: **Sci. American, v. 203, no. 4, p. 128-131, 135-140, 34 illus. (8 col.), graph, Oct. 1960.**

A projection of laboratory experiments in high speed impact to meteorite impacts. Low speed impacts (to approx. 1,500 f.p.s. [feet per second] result in penetration by an unbroken projectile. At higher speeds the projectile breaks up and the crater becomes more hemispherical. Projectiles and targets behave like fluids at speeds above 8,000 f.p.s. until the crater is formed and energy largely expended, when the solid target regains its structural strength. As yet no satisfactory comprehensive theory for fluid impact is available. Laboratory impacts on rock suggest that its low tensile strength is the cause of brecciation of a large amount of rock which is thrown out of the crater by elastic rebound and tension waves. Meteor Crater and the lunar crater Tycho are discussed. Gravity effects, not easily scaled down in a laboratory experiment may explain the shallow meteor and lunar craters, and the central peaks of lunar craters. "Guesstimates" of the size of the meteorite which made Meteor Crater are given at 10,000-60,000 tons.--R.F. McAllister.

**3-469. Battey, M.H. THE RELATIONSHIP BETWEEN PREFERRED ORIENTATION OF OLIVINE IN DUNITE AND THE TECTONIC ENVIRONMENT: Am. Jour. Sci., v. 258, no. 10, p. 716-727, 2 maps, diags., Dec. 1960, 8 refs.**

It is now well known that the olivine crystals of peridotites often have a strong tendency to a common orientation. Information on olivine fabrics was summarized by Turner with the addition of much new data, and Ladurner has recently surveyed the literature again and provided further examples of preferred orientation. Most of the studies of olivine orientation recorded in these papers have, however, been made without reference to the geographical orientation of the rock specimens in the field, so that the relationship of the axes of the oriented crystals to the boundary of the parent peridotite body, or to local tectonic directions, are not known (except in so far as fissility planes or chromite layers in the hand specimen are assumed to lie in particular tectonic orientation). The present contribution attempts to relate the orientation of olivine crystals in the type dunite, from Dun Mountain, Nelson, New Zealand, already made known by Turner to the tectonic setting of the Nelson peridotite belt.--Auth.

**3-470. Heezen, Bruce C. THE RIFT IN THE OCEAN FLOOR: Sci. American, v. 203, no. 4, p. 98-110, 2 illus., 5 maps, 4 secs., 11 profiles, diag., Oct. 1960.**

A 40,000-mi. long submerged mountain range is described. It is split lengthwise along its crest by a rift averaging 6,000 ft. deep and 8-30 mi. wide for hundreds of miles. The mid-Atlantic ridge, the Albatross plateau of the eastern Pacific, and the Carlsberg ridge of the Indian Ocean are parts of this range. World-wide evidences of the range and rift are found under all oceans and on land along the African rift valleys, the central Icelandic graben, the Palestine rift, the Great Alpine fault of New Zealand, and the San Andreas fault complex. Earthquake studies show a concentration of epicenters along the ridge, presumably connected with an active crustal fracture which is the rift, and upthrust, crumpled basic rock which forms the range. It is shown that continental drift theories are not satisfactory to explain the range and rift even with supporting evidence from paleomagnetic studies, and an expanding earth concept is invoked, with continuous formation of range and rift. The influence of convection cells in the mantle is discussed and largely rejected as a cause.--R.F. McAllister.

**3-471. Reitan, Paul H. THE EARTH'S VOLUME CHANGE AND ITS SIGNIFICANCE FOR OROGENESIS: Jour. Geology, v. 68, no. 6, p. 678-680, table, Nov. 1960, 19 refs.**

Recent studies on the thermal history of the earth allow the net volume change of the earth due to temperature changes during the last $10^9$ years to be calculated. The circumference changes for 4 models vary from -13 km. (contraction) to approximately +31 km. (expansion). From this it appears that orogeny cannot be explained as the result of contraction due to heat loss.--Auth.

## 4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-427, 3-436; Geomorphology 3-448, 3-449, 3-450; Paleontology 3-495; Geochemistry 3-530; Sedimentary Petrology 3-604, 3-605; Fuels 3-647.

**3-472. Connell, James F.L. A CATALOG OF TYPE LOCALITIES OF COASTAL PLAIN STRATIGRAPHIC UNITS: Southeastern Geology, v. 2, no. 2, p. 49-126, Nov. 1960.**

A list of the majority of the surface and subsurface units occurring in the Atlantic and Gulf Coastal Plain is presented. Where possible these are arranged in proper stratigraphic sequence. Units are listed by states from Texas to Massachusetts. Discarded names, synonyms, and neotype localities are included for clarity and completeness. Geographic locations are described as completely as possible.--Auth.

**3-473. Bass, Manuel N. GRENVILLE BOUNDARY IN OHIO: Jour. Geology, v. 68, no. 6, p. 673-677, map, 3 tables, Nov. 1960, 7 refs.**

Basement rocks penetrated in deep wells in Ohio can be sharply divided by a boundary trending slightly W. of N. into high-grade metamorphic rocks on the E. and unmetamorphosed igneous and sedimentary rocks on the W. Micas from the metamorphic rocks give Rb-Sr ages between 900 to 1,000 million years, indicating that they are part of the Grenville orogenic belt. The sharp lithologic contrast across the boundary suggests that it is truly the Grenville boundary. The unmetamorphosed igneous rocks W. of the boundary are similar to those from basement wells in Illinois and Indiana and from outcrops in southern Wisconsin, the St. Francis Mountains, and the Arbuckle Mountains. Micas and feldspars from the outcropping rocks give Rb-Sr ages of 1,350 to 1,450 million years. The writer thinks that all these rocks W. of the boundary comprise a nonorogenic igneous province, and therefore the rocks W. of the boundary in Ohio will prove to be older than the rocks of the Grenville orogenic belt.--Auth.

**3-474. Cady, Wallace M., and E-an Zen. STRATIGRAPHIC RELATIONSHIPS OF THE LOWER ORDOVICIAN CHIPMAN FORMATION IN WEST-CENTRAL VERMONT: Am. Jour. Sci., v. 258, no. 10, p. 728-739, 3 maps, secs., Dec. 1960, 7 refs.**

The Chipman formation includes 4 members: the Burchards, characterized by limestone with dolomitic mottling; the Weybridge, composed of limestone with thin interbeds of sandy limestone; the Beldens, made up of interbedded limestone and massive dolomite; and the Bridport dolomite member, consisting of massive dolomitic beds, which in the Cornwall area interfinger with limestones of the Chipman formation. Nearly a century ago Augustus Wing correlated strata of the Weybridge and Beldens with those of the Bridport dolomite. This correlation has been recently reaffirmed by Marshall Kay, who also recognized the faunal affinity of the Weybridge member of the Chipman with late Beekmantown age. Recent mapping by the authors, particularly by Zen in the Sudbury-Brandon area, shows that the sequence of the Burchards, Weybridge, and Beldens members, though generally in about that order, is locally much varied; also the Weybridge is locally missing in western areas and the Burchards is missing in some areas to the E. The irregular distribution of the Burchards, characterized by localized fossils, suggests biostromal deposits. These deposits apparently formed offshore from the Bridport dolomite member, which was deposited in nearshore shallows that fringed the eastern Adirondack area.--Auth.

**3-475.** Langenheim, Ralph L., Jr., and Herbert Tischler. **MISSISSIPPIAN AND DEVONIAN PALEONTOLOGY AND STRATIGRAPHY, QUARTZ SPRING AREA, INYO COUNTY, CALIFORNIA: California, Univ., Pubs. Geol. Sci., v. 38, no. 2, p. 89-150, 21 figs. incl. 3 illus., map, 4 charts, 1960, 59 refs.**

The Late Devonian and Mississippian sequence of the Quartz Spring area forms a part of the deposits belonging to the miogeosynclinal carbonate and detrital province of the Mississippian system in the Great Basin. Deposition of these rocks in the Quartz Spring area began with accumulation of the newly named Quartz Spring sandstone member of the Lost Burro formation. This Late Devonian unit, consisting of quartzite and interbedded sandy dolomite and limestone, contains a fauna characterized by Cyrtospirifer cf. C. monticola Haynes. Thereafter the Early Mississippian Tin Mountain limestone, consisting of a lower, argillaceous limestone member of lagoonal or mudflat origin succeeded by an upper, crinoidal limestone member deposited on an offshore bar or organic bank, was laid down. The fauna of the Tin Mountain limestone correlates with the "Madison fauna" of western North America and includes the following new species of tetracorals: Clisiophyllum (?) panamintense, Ekvasophyllum eastoni, Enygmophyllum californiense, Meniscophyllum durhami, and Rylstonia columnirotata. Enygmophyllum californiense and Rylstonia columnirotata are the first representatives of their genera to be described from North America. The Late Mississippian Perdido formation consits of a lower limestone member and an upper siltstone member, recording a progressive decrease in the proportion of marine sedimentation during Late Mississippian time. Fossils are generally rare in the Perdido formation, but several thin limestone layers near the top are abundantly fossiliferous. One of these is a goniatite coquina formed chiefly of specimens of Cravenoceras hesperium Miller and Furnish. The overlying Rest Spring shale is of doubtful Mississippian or Pennsylvanian age, but lithologically resembles the Mississippian Chainman shale member of the White Pine shale.--Auth.

**3-476.** Bell, Walter A. **MISSISSIPPIAN HORTON GROUP OF TYPE WINDSOR-HORTON DISTRICT, NOVA SCOTIA: Canada, Geol. Survey, Mem. 314, 112 p., 24 pls., 1960, 67 refs.**

This report presents an outline of the stratigraphy and structure of the nonmarine Horton group as it occurs in its type Horton-Windsor area, together with a description and illustration of plants and invertebrates that have been gathered from the group. In the restricted type area the group is divided into 2 formations, the Horton Bluff and conformably overlying Cheverie. The deposits are fluviatile and fluvio-lacustrine, the latter being largely confined to a middle member of the Horton Bluff formation. Soil zones, as indicated by siltstones bearing abundant rootlets and small stems normal to the bedding, occur at various horizons throughout the entire group, but are particularly abundant in the upper of 3 members into which the Horton Bluff formation is arbitrarily divided.

Nineteen plants and 10 invertebrates from the Horton group are described, and 13 of the plants and 8 of the invertebrates are specifically named. New species comprise 2 plants, Triletes cheveriensis, Sphenopteris strigosa, and 3 invertebrates, viz., Spirorbis avonensis, Limnoprimitia? hortonensis and Euestheria lirella. The Horton flora is considered to be an early part of the nearly world-wide Triphyllopteris-Lepidodendropsis-Rhacopteris flora. A Tournaisian age is established by an early Visean age of the marine fauna of Windsor limestones that overlie the Horton group within the area. For comparative purposes the report includes a description of 6 plant species that have been gathered from the Windsor group or from its equivalent in Eastern Canada.--Auth.

**3-477.** Atherton, Elwood, and others. **DIFFERENTIATION OF CASEYVILLE (PENNSYLVANIAN) AND CHESTER (MISSISSIPPIAN) SEDIMENTS IN THE ILLINOIS BASIN: Illinois State Geol. Survey, Circ. 306, 36 p., 14 figs., 3 tables, 1960, 17 refs.**

Differentiation of Caseyville and Mansfield (Pennsylvanian) from Chester (Mississippian) clastics in the Illinois basin is complicated by the many properties they have in common. Criteria that distinguish between these sediments are reviewed and evaluated. These criteria are based on the stratigraphic sequence, lithology, mineralogy, and geophysical logs.

Some of the most reliable indices of the Caseyville clastics are quartz pebbles, siderite, minable coals, conspicuous mica, and siltier shales with higher resistivity. Reflecting the greater importance of marine sedimentation in the Chester are such typical characteristics of Chester clastics as detrital carbonate, red and green shales, marine fossils, and less kaolinite.

Although these and other criteria have basin-wide applicability, regional variations in both Caseyville and Chester sedimentation in a number of areas within the basin make recognition of the unconformity locally difficult.

Several problems associated with the development of the Mississippian-Pennsylvanian unconformity and its control over basal Pennsylvanian sedimentation are pointed out.--Auth.

**3-478.** Minato, Masao. **THE BOUNDARY BETWEEN THE LOWER AND UPPER CARBONIFEROUS IN JAPAN: Am. Jour. Sci., v. 258, no. 9, p. 637-663, map, secs., table, Nov. 1960, 52 refs.**

A review of the stratigraphy and faunas of the Carboniferous rocks of Japan indicates that 2 systems, Mississippian and Pennsylvanian, are justified, and that the boundary lies between the Onimaru series and the Nagaiwa series. The uppermost Mississippian is the zone of Neokoninckophyllum, and the base of the Pennsylvanian includes the Sabukura stage which immediately underlies the zone of Profusulinella. In most areas in Japan the Pennsylvanian section does not extend above the zone of Fusulina and is overlain unconformably by early Permian formations carrying the Pseudoschwagerina fauna, but in the Fukuji district the Pennsylvanian runs up through about 50 m. of the zone of *Triticites*.

The Mississippian in Japan consists largely of dark slates with large amounts of tuffaceous material. The Pennsylvanian, on the contrary, is largely calcareous.--Auth.

3-479. Harker, Peter, and R. Thorsteinsson. **PERMIAN ROCKS AND FAUNAS OF GRINNELL PENINSULA, ARCTIC ARCHIPELAGO: Canada, Geol. Survey, Mem. 309, 89 p., 9 figs. incl. 2 maps, sec., 25 pls., 7 tables, 1960, 154 refs.**

Marine Permian deposits are widespread in the Canadian Arctic Islands but their faunas and age relationships have received little systematic study. This report describes the Permian rocks and faunas of Grinnell Peninsula, where the section consists of 2 highly fossiliferous formations.

The older formation, the Belcher Channel, which is mainly limestone, rests with angular unconformity on the Ordovician and contains the fusulinids *Schubertella*, *Pseudofusulinella*, *Schwagerina*, and *Parafusulina*, corals, and a few brachiopods. The fossils indicate that the formation is mainly of Artinskian age.

The younger formation, the Assistance, consists of weakly consolidated glauconitic sandstones and is transgressive; elsewhere in the Canadian Arctic it rests on rocks ranging in age from Ordovician to Devonian. It contains an abundant and well-preserved fauna with many brachiopods, including species of *Streptorhynchus*, *Derbyia*, *Dictyoclostus*, *Muirwoodia*, *Kochiproductus*, *Waagenoconcha*, *Stenoscisma*, *Rhynchopora*, *Pterospirifer*, and *Spiriferella*. The ammonoids *Pseudogastrioceras* and *Metalegoceras* also occur. Similar faunas considered to be approximately contemporaneous occur at many localities in boreal regions and are here referred to as the Arctic Permian fauna. The Arctic Permian fauna cannot readily be assigned to any well-established marine Permian stage and is referred to the Svalbardian, recently proposed for marine equivalents of the Kungurian and lying between the Artinskian and the Kazanian.--P. Harker.

3-480. Coogan, Alan H. **STRATIGRAPHY AND PALEONTOLOGY OF THE PERMIAN NOSONI AND DEKKAS FORMATIONS (BOLLIBOKKA GROUP): California, Univ., Pubs. Geol. Sci., v. 36, no. 5, p. 243-315, 22 figs. incl. 2 maps, charts, graphs, 6 pls., 13 tables, 1960, 70 refs.**

The Nosoni and Dekkas formations, comprising the newly named Bollibokka group, consist of basic pyroclastic rocks, flows, and interbedded sedimentary rocks more than 10,000 ft. thick. The new group name is proposed for these rocks because it designates a mappable lithologic unit and because the rocks are not readily subdivided into 2 formations everywhere they crop out. The type locality of the Bollibokka group is along Nosoni Creek, Shasta County, California.

The lower unit of the group, the Nosoni formation, also with its type locality as Nosoni Creek, is 6,200 ft. thick and consists of tuff, tuff breccia, basalt, andesite, and interbedded sedimentary rocks. The lowest Nosoni member, conformably overlying the McCloud limestone, is a black medium-bedded chert, 148 ft. thick. The second member, 1,495 ft. thick, is primarily composed of bedded green tuff, tuffaceous conglomerate, tuff breccia, and tuffaceous sandstone. The third member consists of purple medium-bedded tuff, tuff breccia, tuffaceous conglomerate, sandstone, red fissile shale, and black fossiliferous shale 3,265 ft. thick. The fourth and highest member is 1,440 ft. thick and consists largely of black medium-bedded silty shale, often richly fossiliferous. Andesitic and basaltic flows occur throughout the formation.

The upper unit of the group, the Dekkas formation, has its type locality along Dekkas Creek. Much of the type Dekkas formation as mapped by Diller is the lateral equivalent of the type Nosoni formation. At Nosoni Creek the lower limit of the Dekkas formation is drawn at the base of a thick sequence of massive green tuff breccia which overlies a black shale unit. The contact with the overlying Triassic Pit shale is conformable.

The fauna of the group is dominated by species of the fusulinid foraminifer *Parafusulina* and productid brachiopods. Four subgenera of *Parafusulina* are recognized. The subgenus *Parafusulina* (*Parafusulina*) is restricted to species like the genotype, and 2 new subgenera are described. *Monodiexodina* Sosnina is reduced to subgeneric rank within *Parafusulina*. A new species of lophophyllid coral and 4 new productid species are described from the Nosoni fauna. The fauna has close affinities with the middle Permian fauna of western Texas and northern Mexico and less close but definite affinities with the fauna of the Phosphoria formation. Faunal similarities indicate that the more than 10,000 ft. of strata that comprise the Bollibokka group were deposited in the upper part of the biozone of *Parafusulina* and belong to the lower Guadalupian series of the Permian system.

Ecologic analysis suggests that the fossiliferous parts of the Nosoni formation were deposited at moderate to shallow depths in an open sea environment.--Auth.

3-481. Zeigler, John M., and others. **DISCOVERY OF EOCENE SEDIMENTS IN SUBSURFACE OF CAPE COD: Science, v. 132, no. 3437, p. 1397-1398, map, Nov. 11, 1960, 2 refs.**

Spores, pollen, and charcoal taken from 2 wells drilled near the tip of Cape Cod have been identified as Eocene. These are the first Eocene rocks to be identified in Massachusetts. Interpretation of seismic records taken in the Gulf of Maine and Cape Cod Bay will be influenced by this discovery.--Auth.

## 5. PALEONTOLOGY

See also: Areal and Regional Geology 3-432; Structural Geology 3-466; Stratigraphy 3-475, 3-476, 3-479, 3-480.

3-482. Nichols, Rachel H., comp. **BIBLIOGRAPHY OF VERTEBRATE PALEONTOLOGY AND RELATED SUBJECTS: Soc. Vertebrate Paleontology, Bibliog. Vertebrate Paleontology, no. 14, 85 p., 1958-1959, pub. June 1960, refs.**

This bibliography, of approximately 1,300 references, was made up from periodicals received by the library of the American Museum of Natural History in New York City. It is divided into 2 sections; papers are listed alphabetically by author in each.

The first section, "1958 and earlier," contains about 300 items; the remainder appear in the larger section, "Bibliography for 1959."

3-483. Johnson, Ralph G. ENVIRONMENTAL INTERPRETATION OF PLEISTOCENE MARINE SPECIES: Jour. Geology, v. 68, no. 5, p. 575-576, Sept. 1960, 6 refs.

Environmental reconstructions based upon the ecology of a modern species involve 2 assumptions: 1) evolutionary stability, and 2) ecological uniformitarianism. The available evidence suggests that these assumptions are unwarranted. Paleoecological consequences are discussed in brief.--Auth.

3-484. Hoare, Richard D. PENTREMITIDEA FILOSA WHITEAVES FROM THE SILICA FORMATION IN NORTHWESTERN OHIO: Ohio Jour. Sci., v. 60, no. 5, p. 265-267, pl., Sept. 1960.

The presence of the blastoid Pentremitidea filosa Whiteaves is reported in the Silica formation [Middle Devonian] of northwestern Ohio. Three specimens of this species are described and figured.--Auth.

3-485. Leonard, A. Byron, and John C. Frye. WISCONSINAN MOLLUSCAN FAUNAS OF THE ILLINOIS VALLEY REGION: Illinois State Geol. Survey, Circ. 304, 32 p., map, 2 charts, 4 pls., 1960, 8 refs.

In the Illinois Valley region, the Altonian substage (between 50,000 and 70,000 to 28,000 B. P.), Farmdalian substage (28,000 to 22,000 B. P.), and Woodfordian substage (22,000 to 12,500 B. P.) of the Wisconsinan stage are represented by loess, waterlaid clastics, and glacial till. Molluscan faunas of these sediments are here listed both geographically and stratigraphically, and 61 species are illustrated. Woodland faunas distinctive of the Roxana silt (Altonian) are found at 11 localities. Two of the Farmdalian localities yielded aquatic faunas and one woodland fauna. Faunas characteristic of the Woodfordian are abundant but differ in the various geographic areas. The faunas of the several Woodfordian rock-stratigraphic units are not distinguishable, but those of the 3 substages are distinctly so. During Wisconsinan time the glaciers did not produce rigorous climates in Illinois very far from the ice fronts. During Altonian and part of Farmdalian time the southern half of Illinois was heavily forested, but this was not so in Woodfordian time.--Auth.

3-486. Frebold, Hans. THE JURASSIC FAUNAS OF THE CANADIAN ARCTIC. LOWER JURASSIC AND LOWERMOST MIDDLE JURASSIC AMMONITES: Canada, Geol. Survey, Bull. 59, 33 p. 15 pls., 8 maps, table, 1960, 42 refs.

Lower Jurassic and lower Bajocian faunas are widely distributed in the Canadian Arctic, particularly in the Arctic Archipelago, where marine lower Sinemurian, Toarcian, and Bajocian are represented. In the Aklavik Range (northeastern Richardson Mountains, Arctic Coast region) lower and upper Sinemurian rocks are present; farther to the W. lower Sinemurian, upper Pliensbachian, Toarcian, and Bajocian are indicated. The index ammonites described in this paper are: lower Sinemurian-Arietites sensu lato gen. et sp. indet.; upper Sinemurian, zone of Oxynoticeras oxynotum- O. oxynotum (Quenstedt), Gleviceras? sp. indet., Arctoasteroceras jeletzkyi n. gen., n. sp.; upper Sinemurian, probably zone of Echioceras raricostatum-Echioceras sensu lato sp. indet.; Pliensbachian- zone of Amaltheus margaritatus- Amaltheus sp.; Toarcian- Dactylioceras commune (Sowerby), Catacoeloceras spinatum (Frebold), Catacoeloceras polare (Frebold), Harpoceras cf. exaratum (Young and Bird), Pseudolioceras, aff. compactile (Simpson), Grammoceras? sp. indet.; Bajocian- Leioceras opalinum (Reinecke), Pseudolioceras m'clintocki (Haughton), Pleydellia? sp. indet., Erycites cf. howelli (White).

Both in the Richardson Mountains and on the islands the sequence is very incomplete; the Hettangian and most of the Pliensbachian are apparently entirely absent, or, in the case of the Hettangian possibly represented by nonmarine deposits locally. Faunal gaps occur in the Sinemurian and Toarcian. Compared with the NW. European standard section of the Lower Jurassic only 6 of the 17 ammonite zones are found in the Canadian Arctic. Several transgressions and regressions took place in this area during the Early Jurassic and Bajocian. Close faunal and stratigraphic relationships with the Barents shelf and East Greenland are established. Zoogeographically most of the ammonites belong or are related to species of world-wide distribution.--Auth.

3-487. Copeland, M. J., and Thomas E. Bolton. CANADIAN FOSSIL ARTHROPODA. EURYPTERIDA, PHYLLOCARIDA AND DECAPODA: Canada, Geol. Survey, Bull. 60, 84 p., 10 figs. incl. 4 maps, 11 pls., 1960, 5 refs.

Analysis of several relatively small but distinctive Paleozoic and lower Mesozoic arthropod faunas from widely scattered areas in Canada has revealed numerous well-preserved specimens of Eurypterida, Phyllocarida, and Decapoda. In all, 24 species are discussed, of which 7 are new and 12 were previously unrecorded from Canada. Some general comments are made concerning the stratigraphic and geographic distribution of the Arthropoda, and a bibliographic index to Canadian Eurypterida is appended.--Auth.

3-488. Hull, Frank M. A NEW GENUS AND FOUR NEW SPECIES OF FOSSIL DIPTERA FROM MONTANA AND COLORADO: Michigan, Univ., Mus. Paleontology, Contr., v. 15, no. 11, p. 269-279, 8 illus., Aug. 31, 1960, ref.

New genus, new species Archisyrphus opacus and new species Syrphus willistoni, Holopogon archilestes, and Plecia inflata are described. These fossil Diptera were collected from shale of early Miocene or late Oligocene age in the Ruby River basin, Madison County, Montana, and from sandy shale, probably from Florissant, Colorado.--M. Russell.

3-489. McKenna, Malcolm C. THE GEOLABIDINAE, A NEW SUBFAMILY OF EARLY CENOZOIC ERINACEOID INSECTIVORES: California, Univ., Pubs. Geol. Sci., v. 37, no. 2, p. 131-164, 6 figs., 2 tables, 1960, 41 refs.

Metacodon Clark, 1936, is a junior synonym of Geolabis Cope, 1884o. The ancestry of Geolabis is traced back from Oligocene to middle and possibly early Eocene time. Geolabis, Myolestes, and Hypacodon (new genus) are grouped into a new subfamily, the Geolabidinae. Plesiosorex and Meterix are not members of the subfamily. Butler's family Metacodontidae is invalid. The Geolabidinae arose from the basal Erinaceidae (*sensu lato*). The subfamily left no known descendants. By Oligocene time the Geolabidinae had developed a long tubular snout correlated with loss of the zygoma, hypertrophy of the lacrimal foramen, shortened infraorbital canal, a third system of palatal blood and nerve supply, and incipient zalambdodonty. These modifications produce some convergent similarities to such genera as *Solenodon* and *Apternodus*.--Auth.

3-490. Simons, Elwyn L. NEW FOSSIL PRIMATES: A REVIEW OF THE PAST DECADE: Am. Scientist, v. 48, no. 2, p. 179-192, 3 illus., 2 tables, June 1960, 33 refs.

Finds and reports of fossil primates have greatly accelerated during the past decade. Two new, almost complete, Paleocene skulls identified as *Palaechthon* and *Plesiadapis* supply the foundation for the first cranial comparison between Paleocene and subsequent species. Eocene finds and reviews of special interest concern *Notharctus*, *Smilodectes*, *Necrolemur*, and *Phenacolemur*. Studies of additional specimens has strengthened the suggestion that Anthropoidea were reasonably diversified by early Oligocene time. Miocene additions include finds and new reports about *Proconsul*, *Limnopithecus*, *Pliopithecus*, *Sivapithecus*, *Mesopithecus*, *Udabnopithecus*, *Dryopithecus*, *Hispanopithecus*, *Progalago*, and *Cebupithecia*.

Perhaps the most interesting recent find is the Piocene *Oreopithecus* from Tuscany, Italy, currently under intensive study. This species is considered to be hominoid, though not very near man's ancestral line. Among the most significant Pleistocene reports is one concerning *Zinjanthropus*.

Studies of *Gigantopithecus* are reviewed, and recent studies regarding the place of mankind's origin are commented upon.--T. H. W. Loomis.

3-491. Stirton, R. A. A MARINE CARNIVORE FROM THE CLALLAM MIOCENE FORMATION, WASHINGTON, ITS CORRELATION WITH NONMARINE FAUNAS: California, Univ., Pubs. Geol. Sci., v. 36, no. 7, p. 345-368, 4 figs., 1960, 52 refs.

The anterior two-thirds of the cranium of a fissiped carnivore is described. This mammal is apparently related most closely to the basal lineage of the procyonids and bears. Although much larger, it evidently was adapted to live in marine waters much like the living sea otter. It was found in upper exposures of the marine Clallam formation near Slip Point on the shore of Clallam Bay, Clallam County. The sandstone in which it is associated with the remains of cetaceans, sharks, and marine invertebrates is referable to the Miocene. The marine invertebrates of the same age in California are correlated with the Hemingfordian mammalian age of North America.--Auth.

3-492. Giles, Eugene. MULTIVARIATE ANALYSIS OF PLEISTOCENE AND RECENT COYOTES (CANIS LATRANS) FROM CALIFORNIA: California, Univ., Pubs. Geol. Sci., v. 36, no. 8, p. 369-390, map, 3 diags., 6 tables, 1960, 37 refs.

Multivariate analysis of cranial measurements of Rancho La Brea and McKittrick (California Pleistocene) coyotes demonstrates that they form a well-delineated group that should receive at least the subspecific distinction from Recent California coyotes that is usually accorded them (*Canis latrans orcutti*). *C. lepophagus* (Texas Blancan) seems to rate only subspecific distinction within *C. latrans*. Discriminant analysis indicates that *C. petrolei* from Rancho La Brea is dubiously distinguished from *C. latrans orcutti*. The separate species status of *C. andersoni*, also from Rancho La Brea, is questioned.--Auth.

3-493. Savage, Donald E. A SURVEY OF VARIOUS LATE CENOZOIC VERTEBRATE FAUNAS OF THE PANHANDLE OF TEXAS. PART III. FELIDAE. California, Univ., Pubs. Geol. Sci., v. 36, no. 6, p. 317-343, 7 figs., 5 tables, 1960, 26 refs.

The third in a series of papers dealing in this case with fossils from the Cita Canyon quarries, the only source of fossil true cats in the area. The new species *Felis* (*Puma*) *studeri* is described. A review of the known fossil specimens of pumas and jaguars leaves unresolved the question of the origin and time of differentiation of these groups and other large felines. The puma group may be a North American autochthon derived from the Hemphillian "*Pseudaelurus*." Jaguars may have been early or pre-Pleistocene differentiates from the leopards, lions, and tigers within the "Panthera" group in the eastern hemisphere, and may have been late Cenozoic immigrants to the western hemisphere. Alternative interpretations are: 1) *Felis palaeoonca*, and possibly all jaguars, could have been derived from a North American stock; and 2) puma differentiation could have had its earliest representation in a presently unknown Pliocene fauna of Asia.--M. Russell.

3-494. Kesling, Robert V., and Richard A. Ploch. NEW UPPER DEVONIAN CYPRIDINACEAN OSTRACOD FROM SOUTHERN INDIANA: Michigan, Univ., Mus. Paleontology, Contr., v. 15, no. 12, p. 281-292, fig., 3 pls., table, Sept. 2, 1960, 15 refs.

*Eocypridina campbelli*, n. gen., n. sp., is described from the Upper Devonian Blackiston shale in southern Indiana. The environment of deposition was one of foul waters unaffected by deep currents, too toxic to support an endemic fauna. This raises the question of how the ostracods came to be where they were deposited. Several conjectural explanations are offered. The specimens are mostly complete carapaces; more than half reveal muscle-scar details.--M. Russell.

3-495. Axelrod, Daniel I., and William S. Ting. LATE PLIOCENE FLORAS EAST OF THE SIERRA NEVADA: California, Univ., Pubs. Geol. Sci., v. 39, no. 1, 117 p., 10 figs. incl. chart, diags., graphs., 24 pls., 2 tables, 1960, 47 refs.

Late Pliocene sediments at 8 localities distributed from W.-central Nevada southward through Owens Valley and E. to Panamint Valley have yielded spore-pollen floras that represent a humid, W.-slope Sierran pine-fir forest. It interfingered with Coast Forest species in broad, seaward-draining valleys near the present Sierran crest, and with live oak-piñon woodland eastward toward Panamint Valley. Reinvasion of the lowlands of the western Great Basin by the Sierran forest, an area from which it was eliminated during the early Pliocene, was owing to increased rainfall in the late Pliocene. There was fully 20-25 in. more precipitation over the lowlands than there is today, summer rains were present in minor amount, summers were not excessively hot, and winters were mild.

Analysis of late Pliocene vegetation leeward of the present Sierra Nevada, and comparison with contemporaneous floras in western California, shows that the Sierra had only low to moderate relief and that drainage was westward across the range - conclusions supported by geologic evidence. Although the late Pliocene floras represent only one major life zone (transition yellow pine forest), the fossil localities now occur in life zones ranging from lower desert to upper subalpine forest, and which have evolved in response to the 8,000-9,000 ft. of relief that has developed more recently. Since the tectonic activity that accounts for this topography is wholly of Pleistocene age, the physiographic history of the Sierra Nevada deduced by Matthes requires revision.

The following sequence of events seems more nearly to agree with present evidence regarding its history. The Broad Valley-Boreal surface is of late Pliocene, not of Miocene age. In the Yosemite-Sequoia region initial uplift, probably during Nebraskan and/or Aftonian time, was approximately 3,000 ft. at a maximum, and resulted in the development of the Mountain Valley-Chagoopa surfaces in the Sierra, and in the initiation of the grabens (Mono Basin-Long Valley-Owens Valley) to the E. The altitudes of the central Sierran summit valleys were now close to 6,000 ft., the higher peaks near 8,000 ft. This probably was sufficient for the McGee-Glacier Point glaciation during Kansan time to judge from the climatic implications of early Pleistocene floras at sea level in western California. Mid-Pleistocene uplift of approximately 3,000 ft. probably during the Yarmouthian, resulted in entrenchment of the Canyon stage on the W. and E. slopes, and deepening of the grabens to eastward. This was followed by the Sherwin-El Portal glaciation, apparently during Illinoian time. Another uplift of 1,000-1,500 ft. during the succeeding Sangamonian was followed by the Tahoe-Tioga glaciation of Wisconsin time.

Thus Matthes' major tenets - a) a 9,000-ft. upwarp gave the Sierran crest alpine altitudes in the late Pliocene, b) the Canyon stage was cut in the late Pliocene prior to glaciation, and c) the grabens E. of the range were formed by gradual collapse of the Pliocene upwarp during Pleistocene time - are rejected.--Auth.

**3-496.** Crickmay, C.H. **THE OLDER DEVONIAN FAUNAS OF THE NORTHWEST TERRITORIES: 20 p., 11 pls., The Author, Evelyn deMille Books, 616 - 3rd Street S.W., Calgary, Alberta, 1960, 6 refs.**

The earlier Middle Devonian faunas of the Ambocoelia meristoides zone and the Radiastraea arachne are distinguished from each other and from later faunas of the Northwest Territories of Canada. Twenty-one new species, including 3 new genera, of corals and brachiopods are described and related to the named zones in which they occur.--M. Russell.

## 6. GEOPHYSICS

See also: Geologic Maps 3-352 through 3-368, 3-376, 3-377, 3-378, 3-381 through 3-412, 3-420 through 3-425; Engineering Geology 3-648, 3-649, 3-650, 3-655, 3-656.

**3-497.** Shapley, A.H. **INTERNATIONAL GEOPHYSICAL CALENDAR FOR 1961: Science, v. 132, no. 3444, p. 1941-1943, fig., Dec. 30, 1960, ref.**

Coordination of certain types of geophysical observations and analyses throughout the world is accomplished by the advance selection of days and intervals for such work. A committee under the International Council of Scientific Unions has issued the calendar for 1961, together with a brief explanation and examples of how it may be used in planning geophysical programs.--Auth.

**3-498.** Uotila, Urho A. **INVESTIGATIONS ON THE GRAVITY FIELD AND SHAPE OF THE EARTH: Ohio State Univ., Inst. Geodesy, Photogrammetry & Cartography, Pub. no. 10, 92 p., 26 figs. incl. charts, diags., graphs, 12 tables, 1960, 58 refs.; reprinted from: Suomalainen Tiedeakatemia, Toimituksia (Academia Scientiarum Fennicae, Annales), Ser. A, III, Geologica-Geographica, no. 55.**

Geodetic science has had a great need for a worldwide geodetic system which would connect the different regional geodetic systems of the world. In recent years, the need of such a globe-spanning system has also been increasingly recognized by the armed services, as a basis for obtaining the accurate distances and directions so important to national defenses in this jet flight era. These needs, the academic and the military, were combined, with the establishment in 1950 of the World-Wide Gravity Project by Dr. Heiskanen.

Under this significant program, observational gravity data from various agencies all over the world were, and continue to be, channeled into The Ohio State University, Columbus, adjusted to one reference system (the Potsdam system), translated into mean free air gravity anomalies, and finally used for computations of the undulations of the geoid and the deflection of the vertical.

Because of the vast amounts of observational data and the complexity of the computations involved, the writer had the opportunity to develop a variety of new methods and techniques particularly as pertains to high-speed computational operations. The more important of these, which are covered in some detail in this book, are: 1) new method for high-speed computations of the undulations of the geoid; 2) method for high-speed computations of the deflection of the vertical; 3) template method for manual computations of the deflection of the vertical; 4) system for uniform high-speed handling of gravity data; 5) high-speed integration method for the determination of the shape of geopotential surfaces at high elevations; 6) correlations of free air anomalies and elevations on land; 7) general technique for determination and estimation of world free air gravity anomalies; and 8) relating national reference stations to the same world gravity system.--From pref.

The following topics are discussed: gravity reference system, mean free air anomalies, gravity material, computations of undulations of the geoid, computations of deflections of the vertical, anomalies in unsurveyed areas, computations at high elevations, and recent developments.

**3-499.** Kuzhelov, G.K., and Z.A. Krutikhovskaya. **FORMATION OF RESIDUAL MAGNETIZATION AND ITS DISTRIBUTION IN ROCKS. Translated by Paul T. Broneer: Internat. Geology Rev., v. 2, no. 12, p. 1017-1028, maps, secs., diags., graphs, 3 tables, Dec. 1960, 14 refs.**

The result of residual magnetization investigation in the gabbroids of Volyn and the ferruginous quartzites of the Kremenchug anomaly as well as some other metamorphic rocks of the Ukrainian crystalline shield are considered. All the intensely magnetic rocks show a common dependence of the residual magnetization on magnetic susceptibility. A regular deviation of the residual magnetization direction from that of the present magnetic field of the earth is observed. The mechanism of the thermomagnetization process is as follows: the magnetized body at every given moment is a certain cooling layer (the Curie layer) with the Curie temperature. In consequence of the lit-par-lit (gradual) cooling of the rocks their thermomagnetization in nature is necessarily dependent on the law of thin-layer magnetization. A mathematical analysis is given of the regularities observed in the direction of the residual magnetization vector in accordance with the cooling surface position(the Curie layer) with regard to the field of magnetization, the degree of magnetic susceptibility of rocks at the Curie temperature, and the amount of residual magnetization itself. The authors suggest a general scheme of formation of thermoresidual rock magnetization. According to this scheme the different deviations of the residual magnetization vector actually observed may take place with a constant direction of the earth magnetic field. The tectonic-magmatic processes associated with the formation of geological units considered are interpreted in the light of the laws governing the direction of residual magnetization.--Auth.

**3-500. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF CERTAIN AEROMAGNETIC MAPS OF BUCKS, MONTGOMERY, & LEHIGH COUNTIES: Pennsylvania Geol. Survey, Inf. Circ. 42, 6 p., 1960, 5 refs.**

This publication deals with the correlation of geology and aeromagnetic map patterns in 7 quadrangles: Collegeville, Bedminster, Lumberville, Telford, Doylestown, Lansdale, and Ambler [see Sec. 1, Geologic maps, and GeoScience Abstracts 3-58]. These lie within the province of Triassic sandstones, shales, and diabase. The magnetic variations are relatively small and simple. No significant mineralization or variation in structure is indicated.--Auth.

**3-501. Sullivan, Walter. SCIENTISTS DOUBT EARTH EXPANSION: New York Times, v. 110, no. 37,605, p. 66, cols. 3-5, diag., Jan. 8, 1961.**

A theory that the earth has expanded by as much as 40% in surface area has been refuted by Allen Cox and Richard R. Doell. They have shown that the earth's mean radius during the Permian was 6,310 km., only 61 less than now. Their method of analysis is analogous to that of Eratosthenes of ancient Greece, is based on paleomagnetic data, and assumes a stationary Permian magnetic pole.--M. Russell.

**3-502. Bergmann, H.J. HORIZONTAL LOOP EQUIPMENT IN GROUND SURVEY: Can. Mining Jour., v. 81, no. 12, p. 57-61, 10 illus., Dec. 1960.**

A brief description of the Ronka horizontal loop electromagnetic equipment is given, with notes on field operation and remarks on the interpretation of results.

Light and portable horizontal loop equipment has several advantages over other electromagnetic equipment, the greatest being in the immediate interpretation of information in the field. By utilizing the ratio between in-phase and out-of-phase responses, it is possible to measure the relative conductivity of the anomalous zones and to discriminate between conductors of different characteristics. It is also possible to differentiate between the responses from topography and from a conductive body. Information can also be obtained on the dip, width, and depth of conductors.--W.C. Peters.

**3-503. Roman, Irwin. APPARENT RESISTIVITY OF A SINGLE UNIFORM OVERBURDEN: U.S. Geol. Survey, Prof. Paper 365, 99 p., 11 figs. incl. charts, diags., graphs, 38 tables, 1960, 22 refs.**

The interpretation of resistivity observations can be facilitated by the development of theoretical formulas and corresponding curves. A development for a single overburden of uniform thickness has been made and formulas derived that involve infinite series. The series have been evaluated for the geophysical case in which the measuring configuration is located on the surface of the earth. A set of curves that can be superimposed on the field observations has been prepared to permit direct determination of the resistivity and thickness of the overburden, and the resistivity of the underlying medium. Auxiliary tables are given to simplify the numerical evaluations for configurations not covered by the prepared curves.--Auth.

**3-504. Gilman, Ralph. REPORT ON SOME EXPERIMENTAL LONG-PERIOD SEISMOGRAPHS: Seismol. Soc. America, Bull., v. 50, no. 4, p. 553-559, illus., diag., graphs, Oct. 1960, 4 refs.**

The unexpected usefulness in research of the Press-Ewing seismograph system has stimulated further efforts to obtain even higher seismograph sensitivity in the period range beyond 100 sec. A major difficulty has been in maintaining pendulum stability at long periods. This paper describes a stable long-period seismometer and gives results from several seismograph systems incorporating long-period pendulums and galvanometers.--Auth.

**3-505. Peterson, P. CHECKING THE PERFORMANCE OF ELECTRODYNAMIC SEISMOMETERS: Seismol. Soc. America, Bull., v. 50, no. 4, p. 561-562, Oct. 1960, ref.**

The performance of electrodynamic seismometers slowly deteriorates as the magnets age and the hinges become strained. This deterioration can be determined by the extremely simple measurement of the d.c. sensitivities of the seismometer and galvanometer, and the change in the theoretical synchronous magnification can be calculated.--Auth.

**3-506. Watt, P.A. THE APPLICATION OF A D.C. AMPLIFIER TO SEISMIC RECORDING: Seismol. Soc. America, Bull., v. 50, no. 3, p. 471-476, illus., diags., July 1960, refs.**

The paper describes a D.C. chopper stabilized amplifier which is being used to amplify seismic signals from a Willmore S.P. geophone to a level suitable for direct recording on a 0-1 milliamp pen recorder. The over-all magnification of the system is approximately 10,000, while the amplification of the D.C. amplifier is 60 volts per microamp. The frequency response of the amplifier is D.C. to 75 cycles per sec. (3 d.b. down).--Auth.

3-507. Ingram, R.E. AN INTEGRAL SOLUTION OF THE ELECTROMAGNETIC SEISMOGRAPH EQUATION: Seismol. Soc. America, Bull., v. 50, no. 3, p. 461-465, July 1960, 5 refs.

In investigating the response of an electromagnetic seismograph to various ground movements it is advantageous to have the solution of the differential equation as an integral. This is done by finding the Green's function, f(s), for the particular instrument. The angular movement of the galvanometer is then

$$\theta(t) = q\int_0^t f(s)x''(t-s)\,ds$$

where $x(t)$ is the ground movement and prime stands for the operator $d/dt$. It is sufficient to find one function, $F(s)$, with $dF/ds = f(s)$, to give the response to a displacement test, a tapping test, or a ground movement.--Auth.

3-508. Flinn, Edward A. LOCAL EARTHQUAKE LOCATION WITH AN ELECTRONIC COMPUTER: Seismol. Soc. America, Bull., v. 50, no. 3, p. 467-470, July 1960, 5 refs.

A straightforward least-squares iterative procedure for locating local earthquakes using only the direct waves $P_g$ and $S_g$ is now in use at the Australian National University. An IBM 650 electronic computer is used for all calculations, including estimates of the probable error of epicentral coordinates, depth of focus, and origin time.--Auth.

3-509. WICHITA MOUNTAINS SEISMOLOGICAL OBSERVATORY: 10 p., 19 figs. incl. 13 illus., map, diags., graph, Geotechnical Corp., 3401 Shiloh Road, Garland, Texas, 1960.

Located in the Wichita Mountains some 15 mi. NW. of Lawton (near Fort Sill), Oklahoma, the Wichita Mountains Seismological Observatory is a prototype detection station designed to study the problem of detecting and identifying both earthquakes and underground chemical and nuclear explosions. The observatory is part of the U.S. seismic improvement program known as Project VELA-UNIFORM.

The new station will use equipment identical to that recommended by the 1958 Geneva Conference of Experts. The site was selected because the minute vibrations of the earth - called "microseismic noise" - which interfere with the detection of signals from distant earthquakes or underground nuclear explosions, are exceptionally small in the Wichita Mountains.

The Observatory has been developed and will be operated by the Geotechnical Corporation of Garland, Texas, under the technical supervision of the U.S. Air Force, Technical Applications Center. The program is under the over-all direction of the U.S. Dept. of Defense, Advanced Research Projects Agency. --L.M. Dane.

3-510. Petrushevsky, B.A. GEOLOGIC CONDITIONS OF EARTHQUAKE OCCURRENCES. Translated by Paul T. Broneer: Internat. Geology Rev., v. 2, no. 12, p. 1039-1046, Dec. 1960, 24 refs.

Earthquakes with foci in the crust originate in the course of geotectonic movements as a result of faulting. In many cases (probably in most of them) fault zones do not extend to the surface and therefore cannot be directly connected or compared with surface faults. If the immediate causes of earthquakes are always faults (such is the standpoint of the majority of scientists now), the geological causes, or geological conditions, of earthquake occurrence are complicated and diverse; hence tectonic movements causing earthquakes take place in different geological environments with different histories of geological development. Seismic and geological investigations of the territory of the U.S.S.R., having been conducted recently by the Institute of the Earth's Physics, Academy of Sciences, U.S.S.R., permit us to assume that differences of the previous geological history (first of all, differences in the history of formation of major geological structures) leave their imprint on the differences of seismicity and peculiarities of the geological attitude.

The above relations are somewhat different in different regions of the western part of the U.S.S.R. There are distinguished: a) zones of Alpine folding, b) zones of young platforms (with a Paleozoic folded basement), c) zones of platforms which underwent rejuvenation in the Neogene-Quaternary epoch (irrespective of the age of folding of their basement).

The analysis of data obtained by seismic investigations using highly sensitive regional seismic stations indicates that these differences can be due to different depth of processes causing earthquakes. Judging from the depths of weak earthquake foci determined by regional stations one can assume that in the Alpine folding zone tectonic processes causing earthquakes primarily develop in the sedimentary layers of the crust and in its granite layer, whereas in zones of the rejuvenated platforms the processes occurring in a basalt layer are of principal significance of seismicity. It is possible that this fact is connected with a more frequent occurrence of very strong earthquakes in the zones of rejuvenated platforms than in the Alpine folded zone, as is seen from the seismostatic materials on Eurasia (excluding the Pacific Asia).--Auth.

3-511. Davis, T. Neil. A FIELD REPORT ON THE ALASKA EARTHQUAKES OF APRIL 7, 1958: Seismol. Soc. America, Bull., v. 50, no. 4, p. 489-510, 14 illus., 3 maps, sec., Oct. 1960, 7 refs.

The Alaska earthquake at 0530 on Apr. 7, 1958 (150° WMT) was the largest (Richter scale 7-7 1/2) of a series of shocks centered in an area near Huslia, Alaska. The field epicenter located at 65°45'N., 155°45'W. lies in the Koyukuk basin where arrested sand dune deposits cover a part of the near-level alluvium deposited by the Koyukuk River. Extensive fracturing occurred in the lake and river ice in the epicentral area and the sand dune deposits were heavily fissured. The most severe damage occurred in a zone approximately 10 mi. wide by 40 mi. long trending NE. from Huslia. Associated with the sand dunes in this zone were large deposits of silt and sand which flowed to the surface from the alluvium beneath the dunes. Because of the distinctive characteristics of these flows they have been termed sand flows to distinguish them from mud flows and sand blows. Associated with the sand flows were surface collapses resulting in near-conical pits as much as 30 ft. deep and up to 120 ft. in diameter. The earthquakes caused little monetary damage, although the main shock registered a Modified Mercalli intensity V or more over an area in excess of 100,000 sq. mi. --Auth.

**3-512.** Matthews, Samuel W. **THE NIGHT THE MOUNTAINS MOVED: Natl. Geog. Mag., v. 117, no. 3, p. 328-359, 26 illus. incl. 20 col., 2 col. maps, March 1960.**

Details of the Montana Hebgen earthquake and Madison Canyon landslide are recorded in photographs, mostly in color. Included are dust clouds raised on a mountainside during one of the aftershocks, tilted trees along a fault scarp, aerial oblique of the Madison landslide, landslips cutting roadway, serpentine warping of fence line, offset sections of road, engineering activity on the landslide mass which dammed the Madison River, Red Canyon fault scarp, earthquake damage to buildings, and increased geyser activity in Yellowstone Park. The text records personal experiences during the quake and a summary description of the quake, landslide, investigations, and reconstruction required.--M. Russell.

**3-513.** Stauder, William V. **THREE KAMCHATKA EARTHQUAKES: Seismol. Soc. America, Bull., v. 50, no. 3, p. 347-388, map, graph, diags., 10 tables, July 1960, 16 refs.**

Three earthquakes, 2 with previously determined fault-plane solutions, are selected in order to study the relation between the S waves and the source mechanism. The S waves are observed at favorable epicentral distances at stations distributed in all quadrants about the epicenter. The earthquakes are of a focal depth of 40 to 60 km. and belong to the aftershock sequence of the great earthquake of Nov. 4, 1952. The direction of first motion and the plane of polarization of S are determined by the construction of particle-motion diagrams.

In the case of the 2 earthquakes for which the fault-plane solutions have been published, no correspondence is found between the observed S wave data and the character of the S motion expected on the basis of the given nodal planes of P, whether the source be considered as a single couple or as a double couple. For the third earthquake it is found that the first motion of P is compressional along all rays leaving the focus downward and that the S waves are strongly SV polarized. No faulting mechanism can explain this distribution of the motion in the initial P and S phases. The motion is explained as corresponding to that generated by a simple force acting almost vertically downward. Graphical and analytical techniques of analysis determine the trend of the force at the source to be N.12°W., with a plunge of 85°. A reconsideration of the other 2 shocks shows that these, too, are better explained by a simple force source than by a faulting mechanism.--Auth.

**3-514.** Stauder, William V. **S WAVES AND FOCAL MECHANISMS: THE STATE OF THE QUESTION: Seismol. Soc. America, Bull., v. 50, no. 3, p. 333-346, July 1960, 32 refs.**

The questions usually discussed with respect to the use of S waves in determining the character of an earthquake focus concern the ambiguity of the fault-plane solution from P waves and the problem of a single couple vs. a double couple as the model of an earthquake focus. Recent papers on the subject of the earthquake mechanisms bring forward more basic questions concerning the adequacy of focal models. The theory of point sources and previous applications of S waves to mechanism studies are reviewed as guides to further investigation.--Auth.

**3-515.** Stauder, William V. **S WAVES: ALASKA AND OTHER EARTHQUAKES: Seismol. Soc. America, Bull., v. 50, no. 4, p. 581-597, 9 figs., 4 tables, Oct. 1960, 11 refs.**

Techniques of S wave analysis are used to investigate the focal mechanism of 4 earthquakes. In all cases the results of the S wave analysis agree with previously determined P wave solutions and conform to a dipole with moment or single couple as the point model of the focus. Further, the data from S waves select one of the 2 nodal planes of P as the fault plane. Small errors in the determination of the angle of polarization of S are shown to result in scatter in the data of a peculiar character which might lead to misinterpretation. The same methods of analysis which in the present instances show excellent agreement with a dipole with moment source are the methods which in a previous paper required a single force type mechanism for a different group of earthquakes.--Auth.

**3-516.** Nafe, John E., and James N. Brune. **OBSERVATIONS OF PHASE VELOCITY FOR RAYLEIGH WAVES IN THE PERIOD RANGE 100 TO 400 SECONDS: Seismol. Soc. America, Bull., v. 50, no. 3, p. 427-439, map, graphs, 4 tables, July 1960, 10 refs.**

Phase velocity as a function of period has been determined for Rayleigh waves in the period range 100 to 400 secs. The results were derived from a study of seismograms from the southeastern Alaska earthquake of July 10, 1958, and from published data on the Assam earthquake of Aug. 15, 1960. The method depends on measurement of the travel time of wave crests along an arc of known length, with proper correction for change of period with distance. For observations of a single Rayleigh wave train at a single pair of observing stations, crest identification is uncertain, and so too is the resulting curve of phase velocity versus period. A set of phase velocity curves may be computed, each one corresponding to a different choice of crest identification. Only one of these is consistent with the data from several earthquakes and several pairs of observing stations. In the present work, high precision in phase velocity measurement is achieved by using the observations of the Rayleigh waves $R_3$ and $R_5$ at Pasadena of the Assam earthquake. Data from the southeastern Alaska earthquake are used to resolve the ambiguity resulting from uncertainty in crest identification. The fine phase velocity curve is estimated to be accurate to better than 1% in the range of periods 100 to 400 secs.--Auth.

**3-517.** Willis, David E., and James T. Wilson. **MAXIMUM VERTICAL GROUND DISPLACEMENT OF SEISMIC WAVES GENERATED BY EXPLOSIVE BLASTS: Seismol. Soc. America, Bull., v. 50, no. 3, p. 455-459, graph, July 1960, 10 refs.**

An approximate first-power relationship was found between the maximum vertical component of ground displacement and the charge size from a number of quarry shots. The maximum vertical ground displacement, normalized to the Rainier (1.7 kt.) underground nuclear shot, is presented for a series of explosive shots ranging in size from 1 ton to 19 kilotons and at distances of 1 to nearly 1,000 km.

The following empirical equations were found to fit the observed data:

$$A = \frac{0.65 \pm 0.15}{R^{3/2}} \text{ from 1 to 100 km.}$$

$$A = \frac{(0.013 \pm 0.003)e^{-(0.0072 \pm 0.0003)R}}{R^{1/2}}$$

from 100 to 1,000 km.

where $A$ is the maximum vertical component of ground displacement in centimeters and $R$ is the distance in kilometers.--Auth.

3-518. Deresiewicz, Herbert. THE EFFECT OF BOUNDARIES ON WAVE PROPAGATION IN A LIQUID-FILLED POROUS SOLID: I. REFLECTION OF PLANE WAVES AT A FREE PLANE BOUNDARY (NON-DISSIPATIVE CASE): Seismol. Soc. America, Bull., v. 50, no. 4, p. 599-607, Oct. 1960, 4 refs.

A general solution is deduced of the differential equations which describe the propagation of elastic waves in a nondissipative liquid-filled porous solid. The solution is then used to examine some of the phenomena which arise when each of the 3 body waves predicted by the field equations is, in turn, incident on a plane traction-free boundary. It is found, for example, that an obliquely incident wave of each type in general gives rise to reflected waves of all 3 types.--Auth.

3-519. Satô, Yasuo. SYNTHESIS OF DISPERSED SURFACE WAVES BY MEANS OF FOURIER TRANSFORM: Seismol. Soc. America, Bull., v. 50, no. 3, p. 417-426, 11 figs., July 1960, refs.

Flexural disturbances propagated upon a thin Al plate were studied experimentally. The thickness of the plate is 1.0 mm., and the distances between the source and the observation points are $r$ = 0, 3.0, 5.0, 7.0, 15.0, and 20.0 cm.

Using the method of Fourier transform, the dispersion curve was obtained. It agrees well with the theory, and the thickness of the plate was estimated with good accuracy (0.981 mm.).

Disturbances at the distances 7.0, 3.0, and 0 cm. were numerically reproduced by means of Fourier synthesis from the data obtained at $r$ = 15 cm. and 20 cm., and were compared with the observed disturbances. The agreement of the 2 kinds of curves are fairly good, with a little larger discrepancy for the case $r$ = 0 than for the others.--Auth.

3-520. Macpherson, J.D. ANISOTROPY OF THE ROCK IN THE APPROACHES TO HALIFAX HARBOUR, NOVA SCOTIA: Seismol. Soc. America, Bull., v. 50, no. 4, p. 575-579, map, diag., graph, table, Oct. 1960, 4 refs.

During the summer of 1959 a series of high resolution acoustic refraction profiles were obtained for the Hartlen Point region of the Scotian shelf. The profiles were taken across pairs of the 3 bottomed barium titanate hydrophones, connected by cables to a laboratory on the shore. The fixed positions of these hydrophones enabled the bottom properties to be measured considerably more accurately than is normally possible in water-covered areas. Marked anisotropic effects in the rock bottom were found by the surveys.--Auth.

3-521. Shor, George G., Jr. CRUSTAL STRUCTURE OF THE HAWAIIAN RIDGE NEAR GARDNER PINNACLES: Seismol. Soc. America, Bull., v. 50, no. 4, p. 563-573, 5 figs. incl. map, sec., Oct. 1960, 12 refs.

A series of seismic refraction profiles has been made across a flat bank at Gardner Pinnacles (a pair of volcanic islets on the western Hawaiian ridge) down the side of the ridge and across the adjacent deep to the floor of the Pacific basin. The ridge is composed principally of material with velocities typical of volcanic islands. The high-velocity oceanic crust, found in the oceanic areas adjacent, extends beneath the ridge and up into the center of the rise. The total crustal section is thickened and the Mohorovičić discontinuity depressed beneath the deep as well as beneath the ridge.

The smooth "archipelagic apron" on the N. side of the ridge has at most 20 m. of sediment over a layer with a velocity of 3 km./sec., which could be volcanic and is definitely of higher velocity than normal oceanic sediments.--Auth.

3-522. Berg, Joseph W., Jr., and others. SEISMIC INVESTIGATION OF CRUSTAL STRUCTURE IN THE EASTERN PART OF THE BASIN AND RANGE PROVINCE: Seismol. Soc. America, Bull., v. 50, no. 4, p. 511-535, 3 maps, diags., graphs, 2 tables, Oct. 1960, 41 refs.

Results are presented of seismic studies of 9 quarry blasts, ranging in size from 50,000 to 2,138,000 lbs. of explosives, at Promontory and Lakeside, Utah, during 1956 to 1959, and also of the Rainier (1.7 kt.) and Blanca (23 kt.) nuclear explosions near Mercury, Nevada, on Sept. 19, 1957, and Oct. 30, 1958, respectively. Seismic waves from the blasts were recorded at 17 temporary stations to a distance of about 280 km. and 15 permanent seismograph stations to a distance of about 1,009 km. Time-distance graphs were plotted using first and later arrivals at all of the stations. Depths to refracting horizons were computed using refraction equations for horizontal layers having constant velocities.

The time-distance plot of first seismic arrivals from Promontory, Utah, to Eureka, Nevada, (nearly 355 km.) shows the following velocities: 5.73 km./sec. to a horizontal distance of approximately 76 km., 6.33 km./sec. from 76 to 132 km., and 7.59 km./sec. from 132 to 355 km. The data are interpreted to indicate 2 velocity discontinuities, one at a depth of about 9 km., and the other at a depth of approximately 25 km.

A composite time-distance plot of seismic arrivals from all blasts at Promontory and Lakeside shows that the velocity of recognizable first arrivals changes from 7.59 km./sec. to 7.97 km./sec. at a horizontal distance of about 650 km. from the blast sites. Assuming flat-lying layers, the depth to this third velocity discontinuity is computed to be 72 km.

The time-distance plot of first arrivals for the Blanca nuclear explosion, which was obtained from 4 stations in northern Utah at horizontal distances between 380 and 630 km. from the shotpoint, shows a velocity of 7.44 km./sec. for the recognizable first arrivals of energy between 379 and 464 km. and 7.46 km./sec. for arrivals correlated from 380 to 630 km.

For seismic energy that traveled beneath mountains in the medium characterized by a velocity of approximately 7.5 km./sec., the measurements of arrival times of first seismic energy showed that any warping of the top of the 7.5 km./sec. layer beneath the mountains was not more than a few kilometers.--Auth.

## 7. GEOCHEMISTRY

See also: Mineralogy 3-549, 3-550; Igneous and Metamorphic Petrology 3-597; Mineral Deposits 3-620.

**3-523.** Dunne, James A., and Paul F. Kerr. AN IMPROVED THERMAL HEAD FOR D.T.A. OF CORROSIVE MATERIALS: Am. Mineralogist, v. 45, no. 7/8, p. 881-883, 2 figs., July-Aug. 1960, 5 refs.

Alundum tubing simplifies head design, facilitates specimen well replacement, and protects thermocouples. Curves for 25 to 30 sulfide samples with an accuracy of ±5°C. and sensitivites comparable to kaolinite analyses are obtained without thermocouple replacement.--D.O. Emerson.

**3-524.** Pistorius, Carl W.F.T., and W.E. Sharp. PROPERTIES OF WATER. PART VI. ENTROPY AND GIBBS FREE ENERGY OF WATER IN THE RANGE 10-1000°C AND 1-250,000 BARS: Am. Jour. Sci., v. 258, no. 10, p. 757-768, 8 tables, Dec. 1960, 14 refs.

Tables of entropy and Gibbs free energy of water are presented for temperatures between 10°C. and 1,000°C. and pressures between 1 bar and 250,000 bars. These tables have been prepared by using the thermodynamic data of Hilsenrath, et al. on steam at low pressures and by numerically differentiating and integrating the measured specific volumes of Kennedy and co-workers. The specific volumes above 2,500 bars were those calculated by Knopoff et al. from a modified Thomas-Fermi-Dirac equation of state which interpolated between the shock wave data and the measured data of Kennedy, et al.--Auth.

**3-525.** Faulring, G.M., and others. THERMAL TRANSFORMATIONS AND PROPERTIES OF CRYPTOMELANE: Am. Mineralogist, v. 45, no. 9/10, p. 946-959, 10 illus., diag., graph, 4 tables, Sept.-Oct. 1960, 11 refs.

An unusual occurrence of needles of cryptomelane in cavities in a Mn ore from western Australia is described. X-ray diffraction data for the acicular crystals are indexed in terms of a body-centered tetragonal unit cell although optical examination of the crystals indicates a pseudotetragonal cell. The powder data are more detailed than those previously reported for cryptomelane. Fiber patterns obtained from the crystals, heat-treated in air at various temperatures and times, establish the following thermal transformations and relative orientations parallel to the [001] axis of cryptomelane.

$$\begin{array}{cccc} & [110] & & \\ [001] \xrightarrow{\Delta} & [100] \xrightarrow{\Delta} & [100] \xrightarrow{\Delta} & [110] \\ \text{cryptomelane} & \text{bixbyite} & \text{hausmannite} & \text{spinel} \end{array}$$

A transformation product of cryptomelane indexed in terms of a spinel structure, $a_0 = 8.42$ Å, is reported.

A correlation of thermogravimetric data with phase determinations shows that on continuous heating at 6°C. per minute, fibered cryptomelane does not transform completely to bixbyite before the formation of hausmannite begins. At this heating rate, the critical temperature for formation of bixbyite from the acicular crystals of cryptomelane is approximately 600°C., for the hausmannite approximately 825°C., and for the spinel approximately 1050°C.--Auth.

**3-526.** Fyfe, William S. HYDROTHERMAL SYNTHESIS AND DETERMINATION OF EQUILIBRIUM BETWEEN MINERALS IN THE SUBLIQUIDUS REGION: Jour. Geology, v. 68, no. 5, p. 553-566, 3 figs., table, Sept. 1960, 36 refs.

The basis of the experimental determination of mineral stability by synthetic methods is critically discussed. It is considered that synthesis alone does not necessarily give a true picture of equilibrium relations. Some less frequently used methods of determining equilibrium conditions are briefly discussed.--Auth.

**3-527.** Jamieson, John C., and Julian R. Goldsmith. SOME REACTIONS PRODUCED IN CARBONATES BY GRINDING: Am. Mineralogist, v. 45, no. 7/8, p. 818-827, 2 tables, July-Aug. 1960, 24 refs.

Samples of carbonates were ground in a mechanical mortar for periods up to 3 days, and X-ray powder diffraction patterns were taken at intervals. Calcite was partially converted to aragonite as had been reported by Burns and Bredig. The effect of Mg-substitution in the calcite structure gives an estimate of the local pressures involved in mortar grinding of $CaCO_3$ to be the order of 20,000 bars. Several mixtures of pure carbonates reacted to form heterogeneous solid solutions which could be roughly related to their phase diagrams. Several pure carbonates decomposed, and in the case of $MnCO_3$ at least 2 oxidation states were attained after loss of $CO_2$.--Auth.

**3-528.** Arntson, R.H., and others. SYSTEMS $S\text{-}Na_2O\text{-}H_2O$ AND $S\text{-}H_2O$: APPLICATION TO THE MODE OF ORIGIN OF NATURAL ALKALINE POLYSULFIDE AND THIOSULFATE SOLUTIONS: Am. Jour. Sci., v. 258, no. 8, p. 574-582, fig., 4 tables, Oct. 1960, 17 refs.

S reacts with aqueous NaOH to form sodium sulfide and sodium thiosulfate; in the presence of excess S the polysulfide complex ion $S_x =$ forms, where "x" is approximately 5. The saturation concentrations of S in aqueous NaOH solutions allowed to react with excess of orthorhombic S have been determined at 25°C. and one atmosphere pressure. Inasmuch as alkaline aqueous solutions are known to exist in nature, the reaction of S with NaOH solutions suggests a possible mode of origin of natural sodium polysulfide and thiosulfate solutions. Alkaline aqueous solutions encountering elemental S would react to produce sodium polysulfide and sodium thiosulfate, substances which are capable of forming soluble complex ions with ore-forming substances.--Auth.

3-529. Ferguson, R.B. **THE LOW-TEMPERATURE PHASES OF THE ALKALI FELDSPARS AND THEIR ORIGIN**: Can. Mineralogist, v. 6, pt. 4, p. 415-436, 3 figs. incl. diags., graphs, 2 tables, 1960, 26 refs.

New relationships among the low-temperature alkali feldspars were deduced in part and implied in whole by recent crystal structure analyses of low and high albite and consideration of the electrostatic charge distributions in all the known alkali feldspar structures by Ferguson, Traill & Taylor. In general the most stable low-temperature forms are not those most highly ordered with respect to Al-Si as suggested by Goldsmith & Laves, but those most highly balanced electrostatically: slightly ordered orthoclase and largely ordered low albite. Because of the mobility of the alkali atoms at higher temperatures, appreciable amounts of Na in a cooling K-Na feldspar tend to make the Al-Si framework triclinic so that, after exsolution, the K component is triclinic microcline. There thus exists a series of low-temperature K feldspars varying from orthoclase formed in the presence of relatively little Na, through intermediate microcline to maximum microcline formed in the presence of considerable excess of Na over K. It is shown that the (dimensional) monoclinic to triclinic change in the low-temperature K feldspars occurs at an original alkali feldspar composition of about 20% $NaAlSi_3O_8$. Intermediate microclines very similar to the low-temperature forms may also result from process involving rapid cooling from intermediate temperatures of K feldspars in which Na again played an earlier essential role.

The theory also predicts an analogous series of low-temperature Na feldspars varying from ordinary low-temperature albite formed in the presence of relatively little K, through low-temperature "intermediate albites" to a "maximum albite" formed in the presence of considerable excess of K over Na. Evidence for the existence of such a series is discussed. Intermediate albites formed by rapid cooling from intermediate temperatures apparently also exist.

The ionic picture of the alkali feldspars thus leads to the following low-temperature phases on the phase diagram: orthoclase, orthoclase + maximum albite, intermediate microcline + intermediate albite, maximum microcline + low albite, low albite. Some of the many implications of the theory are discussed.--Auth.

3-530. Reynolds, John H. **THE AGE OF THE ELEMENTS IN THE SOLAR SYSTEM**: Sci. American, v. 203, no. 5, p. 171-174, 176, 178, 180, 182, illus., diag., graphs, Nov. 1960.

Using improvements on several of the usual radioactive age determination techniques, the age of the solid solar system has been put at about 4.6 billion years. Anomalous ages by the U-He method led to discovery of the age of meteorites since breakup, based on length of exposure to cosmic rays. The very presence of $U^{235}$ itself, which is a relatively short lived element, places an upper limit on the age of the solar system. Trapped $Xe^{129}$ from the $I^{129}$ transformation, long since completed, indicates that crystallization of solids must have occurred in the 120-290 million years following $I^{129}$ formation and before its complete decay and loss into space. The article summarizes: a 4.6 billion year old solar system, with meteor breakup in 2 periods, one a billion years ago, the other 20-90 million years ago, and formation of the elements 120-290 million years before solidification of compounds.--R.F. McAllister.

3-531. Sen, Sisir K. **SOME ASPECTS OF THE DISTRIBUTION OF BARIUM, STRONTIUM, IRON, AND TITANIUM IN PLAGIOCLASE FELDSPARS**: Jour. Geology, v. 68, no. 6, p. 638-665, 9 figs., 13 tables, Nov. 1960, 23 refs.

The distribution of Ba, Sr, Fe, and Ti in some natural plagioclases has been studied. The variable contents of these minor elements have been interpreted as being caused mainly by an interaction of temperature and availability. Temperature is advanced as a principal control in increasing the "solubility" of the elements concerned in plagioclases, as explained on crystal chemical grounds. The role of the chemical environment in its 2 major manifestations - the relative availability of the elements and the nature and amount of the coexisting minerals - has been found to be important. The stability of Fe and Ti in plagioclase structure is discussed in connection with exsolution. An association of K with Fe is briefly considered. A general trend of increase of the minor element contents in plagioclases from amphibolite facies to granulite facies to volcanics has been observed. Within plagioclases from the same groups where the differences of respective minor elements contents are significant, e.g., the granulite facies and the volcanics, the trends of variation are more or less parallel, suggesting a common temperature control. The exceptions to this parallelism are caused by factors of availability and exsolution-migration.--Auth.

3-532. Murata, K.J. **OCCURRENCE OF CuCl EMISSION IN VOLCANIC FLAMES**: Am. Jour. Sci., v. 258, no. 10, p. 769-772, table, Dec. 1960, 12 refs.

Four molecular bands recorded in spectrograms taken of volcanic flames during the 1960 eruption of Kilauea prove to be the strongest radiation bands of the molecule CuCl. A comparison of the Cu/Na ratio in the flame and in a previously described Kilauea sublimate suggests that an appreciable part of the Cu that is volatized out of Hawaiian magmas is transported as CuCl.--Auth.

3-533. Evernden, Jack F., and others. **ARGON DIFFUSION IN GLAUCONITE, MICROCLINE, SANIDINE, LEUCITE AND PHLOGOPITE**: Am. Jour. Sci., v. 258, no. 8, p. 583-604, 8 graphs, 5 tables, Oct. 1960, 14 refs.

Data on the diffusion of Ar in sanidine, microcline, phlogopite, glauconite, and leucite are presented. We conclude from these data that:

1) Dynamic lattice changes markedly influence Ar loss at the time of the changes.

2) If Ar diffusion takes place under conditions of no lattice changes, all Ar will be lost at a single activation energy.

3) Glauconite and phlogopite have essentially identical diffusion characteristics.

4) The parameters of the diffusion equations for both feldspar and mica are only explainable on an hypothesis of extreme ordering of the diffusing Ar atoms.

5) Glauconites (and illites), due to their fine grain-size, are susceptible to high Ar loss at a temperature of 100°C. if that temperature is maintained for a few million years. Thus, knowledge of the burial

history of a sample is absolutely essential for each glauconite dated.

6) Feldspar diffusion appears to be a complex of lattice and grain-boundary diffusion, with the lattice unit having dimensions of 10-30 microns.

7) Heating a mica of 1 mm. thickness to 300°C. for a few million years should remove all preexisting Ar, thus rendering impossible the dating of events prior to the last heating.--Auth.

**3-534.** Pearson, G. Raymond, and D. M. Shaw. **TRACE ELEMENTS IN KYANITE, SILLIMANITE AND ANDALUSITE:** Am. Mineralogist, v. 45, no. 7/8, p. 808-817, 5 tables, July-Aug. 1960, 23 refs.

Twelve kyanites, 3 sillimanites, and 7 andalusites were analysed spectrographically for various minor and trace elements. Ga, Cr, Mg, Ti, Li, Cu, V, Zr, and Mn could be measured in most samples; B, Be, and Ba were found in several; Ni, Co, Mo, Sn, Ag, Y, Sc, Sr, and Pb were usually below detection limit. No indisputable differences in trace-element contents were found, but andalusite probably contains less Cr, whereas B, Be, and Ba may be concentrated in sillimanite. It is unlikely that trace elements are factors in the polymorphic relations between these minerals.

The trace-element distribution in aluminum silicates can in general be explained by crystal chemical considerations, but V is rather more abundant than might be expected. Li and B are unexpectedly rich in many samples, suggesting origin under pneumatolytic or greisen conditions: both Li and B could however have come from the parent sediments.

One of each of the minerals was analysed chemically. Slight deficiencies of Al with respect to Si can be explained by substitution of minor and trace elements for Al. Alkali metals are present in small amounts, but Jakob's hypothesis that they are essential constituents is untenable.--Auth.

**3-535.** Moxham, R. L. **MINOR ELEMENT DISTRIBUTION IN SOME METAMORPHIC PYROXENES:** Can. Mineralogist, v. 6, pt. 4, p. 522-545, 7 tables, 1960, 32 refs.

Thirty-eight samples of pyroxene and 5 of amphiboles were obtained from a suite of skarn rocks, pyroxenites, and hybrid rocks collected from various localities of the Grenville of western Quebec and eastern Ontario, and analyzed spectrographically for minor and trace element content. The elements, and their ranges of values were as follows: B, 7-90 p.p.m.; Be, 0-9 p.p.m.; Ga, 0-60 p.p.m.; Cr, trace to 200 p.p.m.; Li, 0-150 p.p.m.; Ti, 200-1,200 p.p.m.; Ni, 1-50 p.p.m.; Mo, none; Co, 5-45 p.p.m.; Cu, 0-50 p.p.m.; V, 8-86 p.p.m.; Zr, 12-117 p.p.m.; Mn, 600-2,800 p.p.m.; Sc, trace-15 p.p.m.; Y, trace-18 p.p.m.; Sn, none; Sr, 17-450 p.p.m.; Pb, trace to 300 p.p.m.; and Ba, 1-44 p.p.m.

The location of the minor elements is discussed in terms of the crystal chemistry of the pyroxenes, and in terms of the known behavior patterns of the elements in rocks and minerals. It is concluded that most of the minor components are, generally, in structural sites in the mineral.

When compared with pyroxenes of igneous genesis, the minerals are conspicuously poorer in most elements except Be, Ga, Sr, and Ba, which are at about the same level as in igneous pyroxenes; B, however, has a higher concentration. This is explained in terms of the abundances of minor elements in the Grenville sediments. It is concluded that, just as in igneous crystallization the bulk composition of the magma influences the minor element composition of the individual minerals, so in metamorphic reconstitution the composition is governed by the country rock.

Calculations show that the total minor element composition of the pyroxenes is less than that of igneous pyroxenes, judging from the literature, and less than that of amphiboles from the same rocks. The method of calculation was devised so that elements were weighted with respect to their natural abundance.--Auth.

**3-536.** Graf, Donald L. **GEOCHEMISTRY OF CARBONATE SEDIMENTS AND SEDIMENTARY CARBONATE ROCKS. PART I. CARBONATE MINERALOGY, CARBONATE SEDIMENTS:** Illinois State Geol. Survey, Circ. 297, 39 p., diag., 3 tables, 1960.

The distribution of major and minor elements in sedimentary carbonate rocks and the mechanisms responsible for this distribution are considered on the basis of published information contained in geologic studies, and in studies of present-day environments of carbonate deposition, isotopic composition of carbonates, and experimental aqueous and nonaqueous carbonate systems. There are 5 parts in this study. Pt. I is a discussion on carbonate rocks, chiefly limestone and dolomite and their unconsolidated equivalents, which have not been subjected to hydrothermal or metamorphic environments. Some discussion of sedimentary magnesite-, siderite-, and rhodochrosite-bearing materials also is included. Pts. 2, 3 and 4 are listed below. Pt. 5, dealing with aqueous carbonate systems, will be published later. An extensive bibliography for all published parts appears in Pt. 4-B.--Auth.

**3-537.** Graf, Donald L. **GEOCHEMISTRY OF CARBONATE SEDIMENTS AND SEDIMENTARY CARBONATE ROCKS. PART II. SEDIMENTARY CARBONATE ROCKS:** Illinois State Geol. Survey, Circ. 298, 43 p., 2 maps, 4 graphs, 5 tables, 1960.

**3-538.** Graf, Donald L. **GEOCHEMISTRY OF CARBONATE SEDIMENTS AND SEDIMENTARY CARBONATE ROCKS. PART III. MINOR ELEMENT DISTRIBUTION:** Illinois State Geol. Survey, Circ. 301, 71 p., 3 graphs, 38 tables, 1960.

**3-539.** Graf, Donald L. **GEOCHEMISTRY OF CARBONATE SEDIMENTS AND SEDIMENTARY CARBONATE ROCKS. PART IV-A. ISOTOPIC COMPOSITION - CHEMICAL ANALYSES:** Illinois State Geol. Survey, Circ. 308, 42 p., 4 tables, 1960.

**3-540.** Graf, Donald L. **GEOCHEMISTRY OF CARBONATE SEDIMENTS AND SEDIMENTARY CARBONATE ROCKS. PART IV-B. BIBLIOGRAPHY:** Illinois State Geol. Survey, Circ. 309, 55 p., 1960, 938 refs.

**3-541.** Sackett, William M. **PROTACTINIUM-231 CONTENT OF OCEAN WATER AND SEDIMENTS:** Science, v. 132, no. 3441, p. 1761-1762, 3 tables, Dec. 9, 1960, 6 refs.

By means of a direct method for determining the nuclide $Pa^{231}$, a deficiency in ocean water was found to be accompanied by unsupported $Pa^{231}$ in ocean sediments. Pa-ionium ratios obtained for a surface and a deep section in the same equatorial core yielded apparent ages which were in agreement with predicted ages.--Auth.

3-542. Becker, Bill. **LIBBY IS TURNING TO FOSSIL STUDY:** New York Times, v. 110, no. 37,605, p. 68, cols. 4-5, Jan. 8, 1961.

Re-187 and I-129 are being investigated as possible agents for radioactive age determinations of fossiliferous rocks as old as Cambrian. The studies are being undertaken at the University of California by Willard F. Libby and George W. Wetherill.--M. Russell.

## 8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 3-525.

**3-543. Savolanti, A.O.M., and M.H. Tyni. A NEW MINERAL-PICKING APPARATUS: Am. Mineralogist, v. 45, no. 7/8, p. 901-903, illus., July-Aug. 1960, 2 refs.**

Mineral grains are pulled by vacuum thru a capillary into a glass collecting bulb. The vacuum is controlled by a finger placed over a hole in the top of the bulb.--D.O. Emerson.

**3-544. Chao, Edward C.T. A DEVICE FOR VIEWING X-RAY PRECESSION PHOTOGRAPHS IN THREE DIMENSIONS: Am. Mineralogist, v. 45, no. 7/8, p. 890-892, 2 illus., July-Aug.1960.**

Precession films of different levels are superimposed at approximately correct heights in a holder of 1/4 in. clear plastic. Because the reciprocal cell can be visualized, the device simplifies indexing, and systematic extinctions of oblique cells are readily observed.--D.O. Emerson.

**3-545. Coats, Robert R. METHOD OF MINIMIZING DAMAGE TO REFRACTOMETERS FROM THE USE OF ARSENIC TRIBROMIDE LIQUIDS: Am. Mineralogist, v. 45, no. 7/8, p. 903-904, July-Aug. 1960, 3 refs.**

The white film on lead-glass refractometer prisms caused by high-index arsenic tribromide liquids can be removed by gently polishing with a slurry of fine tin oxide. The use of the more stable lanthanum borate glass is suggested.--D.O. Emerson.

**3-546. Navias, Louis. INTERFERENCE FIGURES OF LARGE CRYSTALS IMMERSED IN A SPHERE OF LIQUID: Am. Mineralogist, v. 45, no.7/8, p. 898-901, 2 illus., diag., July-Aug. 1960.**

A round bottom glass flask, 3 to 4 cm. diameter, is fitted with a stopper which has a capillary tube to let excess immersion liquid out and metal holder for a crystal specimen. Using low magnification, the optical figure orientation is related to reference marks scribed on the stopper and sphere. The device is useful for rough single crystal orientation and for teaching optical mineralogy.--D. O. Emerson.

**3-547. Sclar, Charles B., and Lee Dillinger. THE MICROSCOPIC DETERMINATION OF THE THICKNESS AND PLANENESS OF PLATELETS IN FINE MATERIALS: Am. Mineralogist, v. 45, no. 7/8, p. 862-870, 4 illus., diag., July-Aug. 1960, 4 refs.**

A procedure has been developed for the direct microscopic determination of the thickness and planeness of both opaque and nonopaque platelets which constitute fine powders ranging from a limiting size of 100 mesh to a nominal size of 5 microns. The procedure consists of 1) orienting the platelets by dusting the sample over the meniscus of an epoxy resin, 2) sectioning the resultant catalyzed resin mount normal to the meniscus and, correspondingly, the broad faces of the platelets, 3) remounting the sectioned block in additional resin to protect the thin layer of oriented platelets, and 4) polishing the sectioned face for microscopic examination in incident light.

The thickness of the platelets exposed on the polished surface of the mount may be measured with a micrometer ocular. The error in the measured or apparent thickness due to deviation of the platelets from the preferred orientation should typically be less than 15% of the true thickness. The planeness or unevenness of the broad faces of the platelets may be assessed by visual inspection of their outlines on the polished mount. These outlines are the profiles of the platelets observed in a direction parallel to their principal plane.

The possibility of extending this method to include the direct measurement of the thickness of platy clay-mineral particles by means of the electron microscope and replication methods is under study. --Auth.

**3-548. Bailey, Edgar H., and Rollin E. Stevens. SELECTIVE STAINING OF K-FELDSPAR AND PLAGIOCLASE ON ROCK SLABS AND THIN SECTIONS: Am. Mineralogist, v. 45, no. 9/10, p. 1020-1025, col. illus., Sept.-Oct. 1960, 7 refs.**

This note describes a new method of selectively staining plagioclase in which a surface etched with hydrofluoric acid is dipped into a solution of barium chloride, rinsed, and treated with a solution of potassium rhodizonate. Plagioclase feldspars other than pure Na feldspar are thus stained a brick red by barium rhodizonate. This procedure is combined with the cobaltinitrite staining of K-feldspar to stain K-feldspar yellow and plagioclase red on polished rock surfaces and uncovered thin sections. --Auth.

**3-549. Molloy, Martin W., and Paul F. Kerr. X-RAY SPECTROCHEMICAL ANALYSIS: AN APPLICATION TO CERTAIN LIGHT ELEMENTS IN CLAY MINERALS AND VOLCANIC GLASS: Am. Mineralogist, v. 45, no. 9/10, p. 911-936, 9 figs. incl. diag., graphs, 7 tables, Sept.-Oct. 1960, 16 refs.**

Recent developments in instrumentation have extended the range of X-ray spectrochemical analysis (X-ray fluorescence) to the lighter elements in the range of atomic number 12 to 22. This includes the significant rock-forming elements Al, Si, K, and Ca, in addition to P, S, and Ti. Improved procedure provides a rapid, nondestructive, quantitative, semi-quantitative, and qualitative analytical method useful in the examination of aluminosilicate minerals and mineraloids. It is also capable of wider application.

The analytical method has been applied to volcanic and related materials from the Marysvale, Utah, U area. The X-ray instrument has been calibrated through the use of artificial mixtures of chemical compounds containing the constituent elements. Previously analyzed reference clay minerals of the American Petroleum Institute Research Project 49 have served to establish the calibration. X-ray analytical data have been obtained for a selection of specimens from the Mt. Belknap series which forms part of the late Tertiary volcanic cover of the Marysvale region. The materials examined include rhyolitic obsidian, volcanic ash, granular igneous rocks, and argillitic alteration specimens. X-ray spectrochemical analyses of the Mt. Belknap series show a limited compositional range. This indicates that the tuffs, glasses, and rhyolites of this series are derived from a uniform magma.--Auth.

3-550. Shaw, D.M. **SPECTROCHEMICAL ANALYSIS OF SILICATES USING THE STALLWOOD JET:** Can. Mineralogist, v. 6, pt. 4, p. 467-482, 3 illus., 3 graphs, 6 tables, 1960, 16 refs.

The effects of irregular slit illumination, polar distribution of elements in the arc plasma, and self-absorption are discussed in relation to the use of the Stallwood jet for D.C. analysis of minor elements in silicates. A general method for simultaneous determination of 19 elements, using a graphite matrix with Pd as internal standard is described. Precision and accuracy are discussed in terms of the standard samples G1 and W1.--Auth.

3-551. Shubnikov, A.V. **THE FUTURE DEVELOPMENT OF CRYSTALLOGRAPHY IN THE LIGHT OF THE RESOLUTIONS OF THE 21st CONGRESS OF THE COMMUNIST PARTY OF THE SOVIET UNION:** Kristallografiya [in translation], v, 5, no. 1, p. 1-9, July-Aug. 1960.

Future work in crystallography in the Soviet Union should include the following objectives: 1) discovery of the laws of formation of crystals; 2) study of the laws of atomic-molecular structure, relating structure and properties; 3) study of the interaction of crystals with their surrounding medium; 4) production and study of crystals required by technology. Various aspects of these objectives are discussed in some detail.--E.G. Ehlers.

3-552. Patchett, J.E., and E.W. Nuffield. **STUDIES OF RADIOACTIVE COMPOUNDS. X - THE SYNTHESIS AND CRYSTALLOGRAPHY OF BRANNERITE:** Can Mineralogist, v. 6, pt. 4, p. 483-490, 5 tables, 1960, 11 refs.

Precession and Weissenberg films of a single crystal of synthesized brannerite show that the compound is monoclinic, $C2/\underline{m}$, with $\underline{a} = 9.87$, $\underline{b} = 3.76$, $\underline{c} = 6.95$ Å, $\beta = 119^\circ 30'$. The cell contains $2[UTi_2O_6]$. Sp. gr. (meas.) = 6.35, (calc.) = 6.36. The cell constants and space group are compatible with the forms observed by Pabst on natural crystals in terms of the theoretical form development predicted by the Donnay generalization of the Bravais law. It suggests that brannerite regains its original structure on ignition.--Auth.

3-553. DeVries, R.C. **MULTIPLE GROWTH TWINNING IN $BaTiO_3$ SINGLE CRYSTALS:** Am. Mineralogist, v. 45, no. 7/8, p. 852-861, 8 figs., July-Aug. 1960, 7 refs.

A novel form of multiple growth twinning in $BaTiO_3$ single crystals is described. The crystal contains three (111) primary twin planes and one (115) secondary twin interface. The twinned crystal appears to have grown from a nucleus which contained all the twin elements and not by successive twinning separated by intervals of growth. From a hard sphere model of the various forms of growth twinning in $BaTiO_3$, it is suggested that $TiO_6$ octahedra can share up to 2 faces.--Auth.

3-554. Desautels, Paul E. **OCCURRENCE OF MULTI-FORM FLUORITE FROM MEXICO:** Am. Mineralogist, v. 45, no. 7/8, p. 884-886, fig., July-Aug. 1960, 6 refs.

The 7 holohedral isometric forms occur on many of the limpid, 1 mm. diameter fluorite crystals that form a druse on polybasite from Las Chispas mine, Arizpé, Sonora, Mexico.--D.O. Emerson.

3-555. Wuensch, Bernhardt J. **THE CRYSTALLOGRAPHY OF MCGOVERNITE, A COMPLEX ARSENOSILICATE:** Am. Mineralogist, v. 45, no. 9/10, p. 937-945, 3 illus., table, Sept.-Oct. 1960, 11 refs.

Mcgovernite has been found to have the largest unit cell yet discovered for an inorganic material which is not a stacking polytype. The mineral has probable space group $R\bar{3}2/\underline{c}$ and unit cell dimensions $\underline{a} = 8.22$ Å, $\underline{c} = 205.5$ Å, as determined from oscillation photographs and confirmed by precession photographs. The primitive rhombohedral cell contains $6\ Mn_9Mg_4Zn_2As_2Si_2O_{17}(OH)_{14}$. The cell dimensions indicate a close relationship to dixenite, another complex arsenosilicate.--Auth.

3-556. Radoslovich, E.W. **"HYDROMUSCOVITE WITH THE $2M_2$ STRUCTURE - A CRITICISM":** Am. Mineralogist, v. 45, no. 7/8, p. 894-898, illus., table, July-Aug. 1960, 7 refs.

The $2M_2$ hydromuscovite of Mt. Lyell, Tasmania, described by Threadgold [GeoScience Abstracts 1-1970] was found by X-ray powder technique to compare more closely to a 2:1 mixture of 1M and $2M_1$ muscovite than to $2M_2$ lepidolite. It will be necessary to prove the existence of $2M_2$ muscovite by single crystal methods and use this material as a standard before the mineral can be identified with certainty from powder data.--D.O. Emerson.

3-557. Ergun, Sabri, and others. **THREE-DIMENSIONAL X-RAY REFLECTIONS FROM ANTHRACITE AND META-ANTHRACITE:** Science, v. 132, no. 3436, p. 1314-1316, 2 graphs., Nov. 4, 1960, 10 refs.

Careful analysis of X-ray scattering intensities of demineralized meta-anthracites and high-rank anthracites formed during the Pennsylvanian geological period has revealed the presence of 3-dimensional (hkl) reflections of graphite, demonstrating unequivocally that coals graphitize with metamorphism. Graphitization has been observed also with a coal formed before the Cambrian period, much earlier than most coals. A significant degree of graphitization occurs by coalification when the graphitelike layers attain a size of 25 to 30 angstroms as compared to 100 Å or more by the heat treatment of amorphous carbons.--Auth.

**3-558. Christ, C.L., and Joan R. Clark. CRYSTAL CHEMICAL STUDIES OF SOME URANYL OXIDE HYDRATES: Am. Mineralogist, v. 45, no. 9/10, p. 1026-1061, 3 figs., 23 tables, Sept.-Oct. 1960, 35 refs.**

Mineralogical and crystal-chemical studies have been made of the closely related uranyl oxide hydrates becquerelite, billietite, fourmarierite, masuyite, schoepite, and vandendriesscheite. An essential feature of the work is the use of X-ray precession techniques with carefully selected single crystals to determine accurately the crystallographic constants, the symmetry, and the structural relations of these minerals. Indices of refraction and optical orientation were determined on crystals both identified and oriented by the X-ray precession method. Similarly identified crystals were used to obtain the indexed powder pattern data listed. The results obtained on the physical properties, the X-ray crystallography, the X-ray powder data, and the optical properties are listed and compared with the work of other investigators in the 23 tables of the paper.

Crystals of schoepite and of vandendriesscheite that are apparently single, actually consist of several crystallographically distinct phases in parallel intergrowth. The spontaneous alteration from one phase to another that occurs in these crystals results from loss of water of hydration. All six of the minerals studied yield strikingly similar pseudo-hexagonal diffraction patterns. A reasonable crystal structure based on these patterns consists of $UO_2(OH)_2$ layers (similar to those proved by Zachariasen to exist in $UO_2F_2$) parallel to the perfect cleavage (001), with the water of hydration and any cations present in interlayer positions.--Auth.

**3-559. Belov, N.V. PROBLEMS IN THE CRYSTAL CHEMISTRY OF THE SILICATES: Kristallografiya [in translation], v. 5, no. 1, p. 10-13, July-Aug. 1960.**

The history of crystal chemistry in the Soviet Union, from its beginnings in 1934, is briefly discussed. One of the most significant contributions is the realization that in the presence of large cations $Si_2O_7$ is the basic structural unit, rather than $SiO_4$. The relationship between the crystal chemistry and setting properties of the cement silicates has been studied.--E.G. Ehlers.

**3-560. Winchell, Horace, and Robert Tilling. REGRESSIONS OF PHYSICAL PROPERTIES ON THE COMPOSITIONS OF CLINOPYROXENES. I. LATTICE CONSTANTS: Am. Jour. Sci., v. 258, no. 8, p. 529-547, graph, 8 tables, Oct. 1960, 25 refs.**

The compositions of clinopyroxenes are represented by 9 variables that may be referred to the formula $ABC_2O_6$, as follows: $x_1 = (Si)_c$, $x_2 = (Al, Fe''', Ti)_b$, $x_3 = (Mg)_b$, $x_4 = (Fe, Mn)_a$, $x_5 = (Ca)_a$, $x_6 = (Al, Fe''')_c$, $x_7 = (Fe, Mn)_b$, $x_8 = (Mg)_a$, $x_9 = (Na, K)_a$; among these the last four ($x_6 \ldots x_9$) are considered dependent upon the others by reasons of space-availability and valence. Regressions of the lattice constants a, b, c, and $\beta$ have been calculated by least squares for 12 specimens of clinopyroxene covering the system diopside-hedenbergite-clinoenstatite-clinohypersthene-pigeonite-augite-jadeite, published by various authors between 1949 and 1956. The maximum difference between observed and calculated values of the linear constants is 0.011 angstrom; of the angular constant, 18 minutes of arc. The standard errors for these regressions are 0.0085, 0.0098, 0.0083 Å. for a, b, and c, and 12 minutes for $\beta$, respectively. More data are needed to test those regressions and improve them, but the evidence suggests that the entire clinopyroxene system can be represented by such linear regressions.--Auth.

**3-561. Clark, Joan R., and Daniel E. Appleman. CRYSTAL STRUCTURE REFINEMENT OF REEDMERGNERITE, THE BORON ANALOG OF ALBITE: Science, v. 132, no. 3442, p. 1837-1838, 2 tables, Dec. 16, 1960, 5 refs.**

Ordering of B in a feldspar crystallographic site $T_1(0)$ has been found in reedmergnerite, which has Si-O and Na-O distances comparable to those in isostructural low albite. If a simple ionic model is assumed, calculated bond strengths yield a considerable charge imbalance in reedmergnerite, an indication of the inadequacy of the model with respect to these complex structures and of the speculative nature of conclusions based on such a model.--Auth.

**3-562. Rumanova, I.M., and N.V. Belov. FALSE SYMMETRY OF LAWSONITE: Kristallografiya [in translation], v. 5, no. 2, p. 199-201, table, Sept.-Oct. 1960, 5 refs.**

Lawsonite does not show false symmetry as indicated by previous investigators, and hence cannot be an illustration of the Templeton effect. All of the atoms can be shown to have the symmetry of the group $C \frac{2}{c} \frac{2}{m} \frac{2}{m} 1$.--E.G. Ehlers.

**3-563. Ilyukhin, V.V., and N.V. Belov. DERIVATION OF THE STRUCTURE OF LOVOZERITE FROM SECTIONS OF THE THREE-DIMENSIONAL PATTERSON FUNCTION: Kristallografiya [in translation], v. 5, no. 2, p. 186-198, 12 figs., 4 tables, Sept.-Oct. 1960, 29 refs.**

The structure of lovozerite, $Na_2ZrSi_6O_{15} \cdot 3H_2O \cdot 0.5NaOH$ has been deduced from sections of the electron density pattern. Si tetrahedra are joined to form a ring structure. The Zr is in octahedral coordination. Each Si tetrahedron has only one of its O corners entering a Zr octahedron, so that the formula for the mineral and the balance of valences imply that one corner must be taken by an OH group. The ring contains six OH groups, giving the basic radical as $[Si_6O_{12}(OH)_6]$.--E.G. Ehlers.

**3-564. Kelsey, C.H., and W.H. Barnes. THE CRYSTAL STRUCTURE OF METAROSSITE: Can. Mineralogist, v. 6, pt. 4, p. 448-466, 6 figs. incl. diags., 7 tables, 1960, 28 refs.**

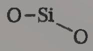
The crystal structure of metarossite, $Ca(VO_3)_2 \cdot 2H_2O$, has been determined from 3-dimensional Patterson and Fourier syntheses and has been refined by 2-dimensional Fourier and difference methods. V coordination polyhedra, in the form of distorted trigonal bipyramids, share edges to form double chains parallel to [010]. These chains are linked through edges and corners to Ca coordination polyhedra, in the form of distorted square antiprisms, which share edges to form chains parallel to [100]. Long H bonds from the water molecules serve as additional links between the Ca and V polyhedra.--Auth.

**3-565.** Zvyagin, B.B. **ELECTRON-DIFFRACTION DETERMINATION OF THE STRUCTURE OF KAOLINITE: Kristallografiya [in translation], v. 5, no. 1, p. 32-42, 6 figs., 3 tables, July-Aug. 1960, 13 refs.**

The structure of a kaolinite from Turbovsky was determined, using the electron diffraction method. The structure consists of an octahedral net and a tetrahedral net joined to it from above, so that the upper bases of the octahedra are oriented with their vertices in the negative and the bases of the tetrahedra in the positive directions of the a axis; the anions in the layers are packed according to a cubic law, although not in closest packing. Nets of tetrahedra are displaced relative to nets of octahedra from the positions corresponding to symmetry planes by an amount - b/3, so that the symmetry planes of layers in the cell are eliminated. Relative to the positions which correspond to closest packing of anions, the lower and upper bases of the octahedra are rotated through angles corresponding to 3° and 5°, and the bases of the tetrahedra on the average through 20°, as their vertices are displaced by different amounts. The common edges of the octahedra are shortened and the octahedra as a whole are somewhat flattened. The Al atoms are displaced toward the lower OH bases, the Si atoms towards the bases of the tetrahedra, whence the atoms of the bases of the polyhedra do not lie in one plane and have several different Z coordinates. The closest atoms in successive layers are grouped in pairs O-OH, which, however, differ somewhat in their lengths.--E.G. Ehlers & auth. p. 40.

**3-566.** Milkey, Robert G. **INFRARED SPECTRA OF SOME TECTOSILICATES: Am. Mineralogist, v. 45, no. 9/10, p. 990-1007, 13 graphs, Sept.-Oct. 1960, 18 refs.**

In the spectra of the tectosilicates analyzed, the major absorption peaks, which are due to the primarily bond-stretching vibrations of the



$$O{-}Si{\searrow}O$$

linkages, occur within a narrow range of the spectrum from 9.1 to 10.2μ. The spectra may be used in some cases, such as for orthoclase and microcline, to distinguish between similar materials. For others, such as noselite, hauynite, and lapis lazuli, the spectra are too similar for purposes of identification. The specificity of such spectra might be increased by extending the study to include wave lengths longer than 15 microns.

The wave lengths of the major absorption peaks show an irregular, but definite, shift toward longer wave lengths as the Al-Si ratio increases: the introduction of Al into the framework increases some of the bond-lengths and decreases bond force constants, resulting in lower frequencies of vibration for the major absorption bands. The infrared spectra could generally be correlated in groups according to similarities in tetrahedral frameworks. However, dissimilar spectra obtained from some tectosilicates with identical frameworks but differing cations, indicated that in some cases the comparatively weak bonds between cation and framework may produce alterations in absorption.

The major absorption peak of most of the tectosilicates showed a high intensity, reflecting the substantial ionic character of the Si-O bond. As little as a few micrograms of some of the tectosilicates may be detected from their absorptions.--Auth.

**3-567.** Zoltai, Tibor. **CLASSIFICATION OF SILICATES AND OTHER MINERALS WITH TETRAHEDRAL STRUCTURES: Am. Mineralogist, v. 45, no. 9/10, p. 960-973, 3 tables, Sept.-Oct. 1960, 35 refs.**

The conventional geometric classification of the silicates is no longer sufficient to classify the ever-increasing number of determined ionic tetrahedral structures. More detail is desirable in the classification, and consequently, new classification criteria are necessary to provide a larger number of subdivisions. The study of the relative energies of isolated rings of tetrahedra suggests that the size of the tetrahedral loops may be used as one additional criterion. It is suggested that another criterion may be based on the different nature of the corner sharing of tetrahedra. A numerical expression, called the sharing coefficient, is derived to cover this criterion. In the proposed classification these 2 criteria are added to the customary silicate classification, and, consequently, the classification proposed is basically in accordance with the conventional scheme.

A large number of silicates can be classified differently depending on whether we consider all tetrahedra of the structure, or only the Si and Al tetrahedra. This problem is not treated consistently in the literature. In some cases Al tetrahedra are disregarded or other tetrahedra, like B, are accepted. It is suggested that all tetrahedrally coordinated cations should be considered as part of the tetrahedral frame of a silicate. This suggestion is supported by the similarity of the observed ionic radii and electronegativity of other 4-coordinated cations with that of Si and Al, and by the analytical data indicating the random distribution of Si and other cations in different tetrahedra of certain silicates.--Auth.

**3-568.** Kullerud, Gunnar, and others. **A SECOND FIND OF EUHEDRAL BORNITE CRYSTALS ON BARITE: Am. Mineralogist, v. 45, no. 9/10, p. 1062-1068, 5 figs. incl. illus., map, Sept.-Oct. 1960, 8 refs.**

Bornite crystals on barite have been found at the Coppercorp Mine [Mamainse Point Cu area], Ontario, Canada, the second locality for this association. The geology resembles that of the upper Michigan Cu area. The bornite cubes, truncated by octahedron faces, prove to be twinned edifices of 2 kinds, which simulate either cubic (a = 21.94 Å) or orthorhombic (a = b = 21.90, c = 10.95 Å) symmetry.--Auth.

**3-569.** Frondel, Clifford, and others. **NEW DATA ON BIRNESSITE AND HOLLANDITE: Am. Mineralogist, v. 45, no. 7/8, p. 871-875, illus., 2 tables, July-Aug. 1960, 9 refs.**

Weathering crusts on Mn ore from Cummington, Massachusetts, and Sterling Hill, New Jersey, were examined by X-ray and found to contain minor amounts of delta-$MnO_2$ (birnessite). The mineral was chemically analyzed. X-ray and chemical analysis of a botryoidal "wad" sample from Langenberg, Saxony, identifies it as a Ba, K, derivative of the $\alpha$-$MnO_2$ structure (hollandite).--D.O. Emerson.

**3-570.** Levinson, Alfred A. SECOND OCCURRENCE OF TODOROKITE: Am. Mineralogist, v. 45, no. 7/8, p. 802-807, 2 tables, July-Aug. 1960, 6 refs.

Todorokite, a hydrated manganese oxide mineral previously reported only from Japan, is described from an occurrence in Cuba. A chemical analysis, X-ray powder spacings, data on various physical properties and occurrence are presented and compared with those of the type todorokite from Japan.--Auth.

**3-571.** Howard, Calhoun L.H., and Paul F. Kerr. BLUE HALITE: Science, v. 132, no. 3443, p. 1886-1887, fig., Dec. 23, 1960, 9 refs.

Remarkable deep blue and occasionally purple forms of halite (rock salt) have long been known. These occur associated with K minerals in the Zechstein basin of northern Germany, elsewhere in Europe, and in North America. In recent laboratory studies, data have been developed which confirm the hypothesis that this coloration in natural salt may be attributed to gamma-ray bombardment by associated K-40 from sylvite, accompanied or followed by structural deformation.--Auth.

**3-572.** Millman, Anthony P. THE DESCLOIZITE-MOTTRAMITE SERIES OF VANADATES FROM MINAS DO LUECA, ANGOLA: Am. Mineralogist, v. 45, no. 7/8, p. 763-773, 5 illus., 3 tables, July-Aug. 1960, 8 refs.

The results are given of a chemical, microchemical and X-ray investigation of V minerals from a new locality in West Africa - Minas do Lueca in Angola - together with comparative data for similar minerals from other localities. A rapid and simple technique of microchemical analysis has been devised which enables accurate discrimination to be made between different members of the descloizite $(Zn)Pb(VO_4)OH$-mottramite $(Cu)Pb(VO_4)OH$ isomorphous series. A description is given of the mode of occurrence and origin of the V minerals at the Lueca Mine, and of the associated tarbuttite $Zn_2PO_4OH$ and volborthite $Cu_3(VO_4)_2 \cdot 3H_2O$.--Auth.

**3-573.** Switzer, George S., and Laura E. Reichen. RE-EXAMINATION OF PILINITE AND ITS IDENTIFICATION WITH BAVENITE: Am. Mineralogist, v. 45, no. 7/8, p. 757-762, 4 tables, July-Aug. 1960, 10 refs.

X-ray powder patterns and a new chemical analysis made on pilinite from the type locality have shown it to be the same mineral as bavenite. The strongest lines in the X-ray powder pattern, in order of decreasing intensity are: 3.71, 3.35, 3.22, 3.03, 2.83, 4.85 Å. The new chemical analysis shows 5.5% BeO which was missed in the original analysis. The formula proposed is $(Be, Al)_4Ca_4(SiO_3)_9 \cdot xH_2O$. It is recommended that the name pilinite be dropped.--Auth.

**3-574.** Young, E.J., and Howard A. Powers. CHEVKINITE IN VOLCANIC ASH: Am. Mineralogist, v. 45, no. 7/8, p. 875-881, 4 illus., 2 tables, July-Aug. 1960, 6 refs.

Chevkinite, a titano-silicate of the Ce earths, is widely distributed as amounts of a thousandth of 1% in the Dubose tuffaceous sand member of the Eocene Whitsett formation of Texas; in an early Pleistocene ash from Hagerman, Idaho; in the middle Pleistocene Pearlette ash of Texas, Kansas, Colorado, Nebraska, Wyoming, Utah, and Nevada, and in the Bandelier tuff of New Mexico. The almost opaque, 0.17 mm. long prismatic crystals, which were formed early, occur as separate phenocrysts in the rhyolitic glass and as inclusions within fayalite, ferroaugite, and sanadine phenocrysts. These occurrences, determined from 60 samples, represent only 6 volcanic eruptions. Chevkinite was not found in the 60 other late Cenozoic ash beds studied. Optical and chemical data are given for chevkinite from La Sal Mountains, Utah, and for pumice from a tuff near Mercury, Nevada.--D.O. Emerson.

**3-575.** Nickel, Ernest H., and others. HOLMQUISTITE FROM BARRAUTE, QUEBEC: Can. Mineralogist, v. 6, pt. 4, p. 504-512, 2 illus., 5 tables, 1960, 11 refs.

A new occurrence of the rare Li amphibole, holmquistite, has been discovered near Barraute, Quebec. It occurs at or near the contact of spodumene pegmatites and hornblende-rich rock. A chemical analysis indicates a composition close to $Li_2(Mg,Fe'')_3(Al,Fe^{*})_2Si_8O_{22}(OH)_2$. The holmquistite is orthorhombic, space $D_{2h}^{16}$-Pnma, with a = 18.30, b = 17.69, and c = 5.30. The optical and physical properties are similar to those of other holmquistites cited in the literature.--Auth.

**3-576.** Seki, Yôtarô. JADEITE IN SANBAGAWA CRYSTALLINE SCHISTS OF CENTRAL JAPAN: Am. Jour. Sci., v. 258, no. 10, p. 705-715, diags., table, Dec. 1960, 22 refs.

Jadeite is observed in pelitic, psammitic, and mafic crystalline schists in a low-grade part of the Sanbagawa metamorphic belt of central Japan. Stable association of jadeite and quartz in some of these schists is believed to show that the temperature and pressure prevailing in the formation of these schists may have been 200-300°C. and 6-12 kilobars respectively.--Auth.

**3-577.** Davis, Gregory A. LAWSONITE AND PUMPELLYITE IN GLAUCOPHANE SCHIST, NORTH BERKELEY HILLS, CALIFORNIA. With Notes on the X-ray Crystallography of Lawsonite, by Adolf Pabst: Am. Jour. Sci., v. 258, no. 10, p. 689-704, 5 illus., 7 tables, Dec. 1960, 21 refs.

A previously undescribed lawsonite-pumpellyite locality in the North Berkeley Hills is characterized by exceptional development of lawsonite as veins and as lithologic layers in glaucophane schist. The glaucophane schist outcrop, a tectonic block in serpentinite, is believed to have been derived at least in part by retrogressive metamorphism of eclogite. Lawsonite-rich layers in the schists and the vein minerals lawsonite and pumpellyite are regarded as products of metamorphic differentiation under conditions of glaucophanitic metamorphism.

Optical and morphological data for lawsonite and pumpellyite are presented together with a new lawsonite chemical analysis and a semi-quantitative spectroscopic analysis of pumpellyite. A description is given of lawsonite-pumpellyite intergrowths and of pumpellyite twinning.

The cell dimensions of lawsonite from 3 California localities and from Cuba have been determined by means of calibrated Weissenberg patterns. All values obtained lie within the limits 8.788 ± 0.008 Å for $a_0$, 13.129 ± 0.010 for $b_0$ and 5.846 ± 0.006 for $c_0$. A powder diffraction pattern giving calculated and observed d values to 1.46 Å has been tabulated. The thermal transformation of lawsonite to metastable hexagonal $CaAl_2Si_2O_8$ has been studied by means of single crystal diffraction. The change can be detected after prolonged heating at temperatures as low as 410°C. In the neighborhood of 700°C. it is complete in an hour or less. At intermediate temperatures partly changed lawsonite may persist for long periods. Single crystal patterns are more sensitive than powder patterns for detecting the beginning and end of the transformation. Lawsonite that had been heated under a bonfire was found to be partly transformed.--Auth.

**3-578. Jiménez de Abeledo, M., and others. RANQUILITE, A CALCIUM URANYL SILICATE: Am. Mineralogist, v. 45, no. 9/10, p. 1078-1086, 4 figs. incl. 3 illus., 3 tables, Sept.-Oct. 1960, 5 refs.**

A new U mineral, named ranquilite, has been found in Mendoza province, Argentina. The probable formula is $1.5CaO \cdot 2UO_3 5SiO_2 \cdot 12H_2O$. The orthorhombic unit cell has $a_0$ = 17.64 Å, $b_0$ = 14.28 Å, and $c_0$ = 18.48 Å. Z. = 8, G. = 3.32. Samples heated to 110-120° and to 130-140°C. show certain changes in the X-ray powder pattern suggesting 2 lower hydrates. After exposure to the air, the original pattern is again obtained.--Auth.

**3-579. Gibbs, G.V., and others. PROTO-AMPHIBOLE, A NEW POLYTYPE: Am. Mineralogist, v. 45, no. 9/10, p. 974-989, 5 figs. incl. illus., 6 tables, Sept.-Oct. 1960, 14 refs.**

An orthorhombic amphibole ($a_0$ = 9.330, $b_0$ = 17.867, $c_0$ = 5.286 Å, ±0.05% with space group Pnmn or Pn2n) has been identified as a phase within the system $Li_2O-MgO-MgF_2-SiO_2$. Its unit cell is 1/2 that of anthophilite ($a_0$ = 18.5, $b_0$ = 17.9, $c_0$ = 5.28 Å; space group Pnma). A new structure type for amphibole, based on the space group Pnmn, is proposed. The term proto-amphibole is used to describe this new polytype, since it appears structurally related to the amphiboles in the same way that proto-enstatite is to the pyroxenes.

Chemical analysis reveals the proto-amphibole studied in greater detail to have the following formula: $Li_{.64}Na_{.05}, Li_{.48}Mg_{1.52} \cdot Mg_{5.00}Si_{7.93}:O_{21.91}F_{2.09}$. Its optical constants for Na light are: $\alpha$ = 1.5759, $\beta$ = 1.5870, $\gamma$ = 1.5928, $2V_{(calc.)} = 71.4^\circ$, $2V_{(meas.)} = 74^\circ$. The presence of Li and the absence of Ca in the melts studied seems essential to the formation of proto-amphibole, a monoclinic fluor-amphibole being otherwise developed.--Auth.

**3-580. Kushiro, Ikuo. Si-Al RELATION IN CLINOPYROXENES FROM IGNEOUS ROCKS: Am. Jour. Sci., v. 258, no. 8, p. 548-554, 3 figs., Oct. 1960, 16 refs.**

By a statistical study of chemical compositions of clinopyroxenes from igneous rocks, it is found that those crystallizing from tholeiitic magma which is oversaturated with $SiO_2$ have higher proportions of Si and lower proportions of Al in the tetrahedral position of the pyroxene structure, whereas those from undersaturated alkali-basalt magma have lower Si and higher Al proportions. It is also noticed that the proportion of Si increases and that of Al in the tetrahedral position decreases during fractionation of the Skaergaard, Stillwater, Black Jack, and Izu-Hakone magmas. These proportions appear to depend on the molecular concentration of $SiO_2$ in the magma at the time of clinopyroxene crystallization. If the magma is deficient in $SiO_2$, a lower proportion of Si is available to the tetrahedral position and the rest of this position is filled with Al. The excess of the negative charge caused by the Si-Al substitution is compensated by the entrance of Ti, Al and $Fe^{3+}$ in the octahedral position. This would account for the common occurrence of Ti-rich augite in the undersaturated alkalic rocks. Higher temperature of the magma would favor the higher proportion of Al in the tetrahedral position and consequently would result in the lower Si proportion. But this effect appears to be subordinate to the composition effect. --Auth.

**3-581. Bilgrami, S.A. SERPENTINITE-LIMESTONE CONTACT AT TALERI MOHAMMAD JAN, ZHOB VALLEY, WEST PAKISTAN: Am. Mineralogist, v. 45, no. 9/10, p. 1008-1019, 4 illus., map, 4 tables, Sept.-Oct. 1960, 16 refs.**

Mineralogical and petrographic description is given of a serpentinite-limestone contact at Taleri Mohammad Jan, West Pakistan. Chemical analyses and optical properties of a diopside, an idocrase, and a clinochlore are given and their possible mode of origin discussed.--Auth.

**3-582. Foster, Margaret D., and others. IRON-RICH MUSCOVITIC MICA FROM THE GRANDFATHER MOUNTAIN AREA, NORTH CAROLINA: Am. Mineralogist, v. 45, no. 7/8, p. 839-851, illus., map, diag., 3 tables, July-Aug. 1960, 26 refs.**

The metamorphic arkoses and arkosic quartzites in the Grandfather Mountain area, North Carolina, contain green micas that have high indices of refraction with the $\beta$ index ranging from 1.603 to 1.619. Detailed study of mica having the highest indices of refraction showed that it is dioctahedral in character, falling between muscovite and phengite in the trisilicic-tetrasilicic dioctahedral K mica series, with considerable proxying of $Fe^{+3}$ for octahedral Al. The green color and high indices of refraction are attributed to the high Fe content and to the presence of both $Fe^{+3}$ and $Fe^{+2}$(8.11% $Fe_2O_3$ and 2.55% FeO).--Auth.

**3-583. Shimoda, Susumu, and Toshio Sudo. AN INTERSTRATIFIED MIXTURE OF MICA CLAY MINERALS: Am. Mineralogist, v. 45, no. 9/10, p. 1069-1077, fig., 3 tables, Sept.-Oct.1960, 9 refs.**

Various kinds of mixed-layer minerals are found in close association with the hydrothermal pyrophyllite diaspore deposit of the Yonago mine, Nagano prefecture, Japan. The reference specimens occur as vein-shaped masses in the pyrophyllite bodies. It almost agrees with allevardite chemically: $SiO_2$, 43.17%; $Al_2O_3$, 33.54%; $Fe_2O_3$, 0.26%; FeO, 0.13%; $TiO_2$, 0.51%; CaO, 0.52%; MgO, 0.65%; $K_2O$, 2.84%; $Na_2O$, 0.38%; $P_2O_5$, tr.; $H_2O$ (+), 10.48%; $H_2O$ (−) 7.75%; Total, 100.23%. X-ray data strongly suggest that the

26.1+1 Å spacing can be attributed to a complex combination of the 10 Å mica clay-mineral structure and its more hydrated forms. Ideally 3 kinds of structures can be considered as "A" (10 Å structure... a mica clay-mineral structure), "B" (12.48 Å structure... the silicate layer alternating with a single layer of water molecules), and "C" (15.16 Å structure... the silicate layer alternating with a double layer of water molecules). It can be appropriately inferred that the 26 Å spacing is nearest to that attributed to a random piling of A+C and B+C structures in equal proportions. It is reasonable to consider that small amounts of K ions are still retained even in B and C structure.--Auth.

**3-584.** Jonas, Edward C., and Herman E. Roberson. PARTICLE SIZE AS A FACTOR INFLUENCING EXPANSION OF THE THREE-LAYER CLAY MINERALS: Am. Mineralogist, v. 45, no. 7/8, p. 828-838, 4 figs., July-Aug. 1960, 14 refs.

Expansion properties of 3-layer clay minerals are the result of an interaction between a binding force, which acts from particle to particle through interlayer cations, and an expansion force created by the adsorption of liquid molecules on interlayer surfaces. The binding force between 2 particles is a function of the charge density on the interlayer surfaces and the areal extent of the particles. The influence of areal extent of the particles on expansion properties is studied in a comparison between 2 size fractions of a single sample and between 2 samples before and after grinding. Fine fractions always contain more expanding layers than coarse fractions. Ground samples always expand more completely than unground samples. It was concluded that mica layers with a high surface charge density can expand provided they have a sufficiently small particle size. There is no simple correlation that can be made between charge density (or silicate composition) and expansion properties.--Auth.

**3-585.** Ostrom, Meredith E. AN INTERLAYER MIXTURE OF THREE CLAY MINERAL TYPES FROM HECTOR, CALIFORNIA: Am. Mineralogist, v. 45, no. 7/8, p. 886-889, 2 figs., July-Aug. 1960, 2 refs.

It is suggested that a clay (trioctahedral with an expanding lattice and a pH of 9.8) from the hectorite locality is a random mixed-layer material and represents an intermediate stage in the alteration of phlogopite to hectorite. At least 2 of the 3 mixed-layer components (9.8, 14.5, and 15.5 Å 001 series) are expandable and all are moderately abundant.--D.O. Emerson.

**3-586.** Loughnan, F.C., and D.C. Craig. AN OCCURRENCE OF FULLY-HYDRATED HALLOYSITE AT MUSWELLBROOK, N.S.W.: Am. Mineralogist, v. 45, no. 7/8, p. 783-790, sec., 2 tables, July-Aug. 1960, 11 refs.

An occurrence of halloysite ($4H_2O$) in commercial quantities, at Muswellbrook, New South Wales, is described. Intrusions of slag derived from the fusion of ferruginous sediments by the underground combustion of coal seams, have partly altered the associated strata to assemblages of tridymite, cristobalite and mullite. It is considered that the halloysite originated from the rehydration of metakaolinite formed by thermal metamorphism of well crystallized kaolinite.--Auth.

**3-587.** Dietrich, Richard V. VIRGINIA MINERAL LOCALITIES (1960 EDITION): Virginia Polytech. Inst., Bull., v. 53, no. 7, Eng. Expt. Sta. Ser. no. 38, 84 p., May 1960, 200 refs.

This bulletin includes and brings up to date data of 2 previous editions, no longer available, Virginia Mineral Localities (1953), and Additions to Virginia Mineral Localities (1955). The physical characteristics, mode of occurrence, and locality are given for 338 minerals which have been reported from Virginia.--M. Russell.

**3-588.** Morrill, Philip, and Robert G. Chaffee. VERMONT MINES AND MINERAL LOCALITIES. PART I. SOUTHERN VERMONT. PART II. NORTHERN VERMONT: 2 v., 9 maps, Hanover, New Hampshire, Dartmouth College Museum, 1957, 1960, refs.

This booklet is an attempt to bring together as much of Vermont mineral locality information as possible. In Pt. 1, the localities are grouped under 13 areas based on highway accessibility. They are further arranged in "trips," each of which starts from a point easily located on any standard road map. An attempt is made to grade the localities into 4 categories, indicated by the kind of type used for the locality name. At the back of the booklet are a township index and a mineral species index. In the second index, references are made in the order of their excellence, fine specimens in good supply coming first.

In Pt. 2, the localities are listed under the townships in which they occur. Most of the localities (other than granite and marble quarries) have route directions starting from a point easily located with the help of a road map. After each locality name, where possible; a map reference is given in parenthesis. The system of reference is based on the U.S. Geological Survey Topographic Quadrangles, scale 1:62,500.--L.M. Dane.

**3-589.** Roy, Supriya. MINERALOGY AND TEXTURE OF THE MANGANESE ORES OF KODUR, SRIKAKULAM DISTRICT, ANDHRA PRADESH, INDIA: Can. Mineralogist, v. 6, pt. 4, p. 491-503, 11 illus., 2 maps, table, 1960, 13 refs.

The Mn ore bodies of Kodur group of mines, Srikakulam district, Andhra Pradesh, India, have been known for a long time for their commerical importance and academic interest. A detailed study of the mineralogy of the ores of this area, not systematically investigated to date, has been attempted, by study of polished sections aided by reflectivity measurement and etch reactions, and by X-ray powder analysis. Among the primary minerals identified, are braunite, jacobsite, hausmannite, and minor pyrolusite. Later invasion of colloidal gel produced a suite of low temperature minerals like cryptomelane, coronadite, and $\gamma$-$MnO_2$. Cryptomelane and pyrolusite are also present as supergene minerals derived from weathering and alteration of primary minerals. The textural relationships of the ore minerals have been described and the paragenesis has been drawn up.--Auth.

**3-590.** Bilgrami, S.A., and R.A. Howie. THE MINERALOGY AND PETROLOGY OF A RODINGITE DIKE, HINDUBAGH, PAKISTAN: Am. Mineralogist, v. 45, no. 7/8, p. 791-801, 4 tables, July-Aug. 1960, 21 refs.

A rodingite dike is described from Pastoki, 15 mi. S. of Hindubagh, Pakistan, and chemical analyses are given of the serpentinite country rock as represented by a xenolith in the dike, of 4 specimens of rodingite, and of a typical unaltered dolerite dike and a peridotite of the area. The mineralogy of the rodingite includes the extensive development of Ca-rich minerals such as prehnite and hydrogrossular, and the dike is traversed by numerous veins of xonotlite. Analyses and optical properties are given for hornblende, prehnite, sphene, chlorite (pycnochlorite), diopside, and xonotlite from the rodingite and for lizardite from the serpentinite xenolith. The chemistry and mineralogy of the rodingite indicate the introduction of Ca, carbon dioxide, and water and the removal of Na and K. The Ca-rich hydrothermal solutions involved may be related to the serpentinization of the peridotite country rocks.--Auth.

## 9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 3-434; Geomorphology 3-455; Geochemistry 3-532; Mineralogy 3-576, 3-577, 3-580, 3-581, 3-590; Mineral Deposits 3-624.

**3-591.** Simpich, Frederick, Jr. FOUNTAIN OF FIRE IN HAWAII: Natl. Geog. Mag., v. 117, no. 3, p. 303-327, 22 col. illus., 2 col. maps, March 1960.

Detailed high-speed color photographs record the various phases of activity of the Nov. 1959 eruption of Kilauea Iki, Hawaii. Lava fountains, lava flows and rivers, close-ups of the active cone, and effect of the eruption on nearby landscape are featured. The text tells of personal experiences of the photographers during the assignment and a summary description of the eruption and investigations carried on by scientists observing it.--M. Russell.

**3-592.** Williams, Howel. VOLCANIC HISTORY OF THE GUATEMALAN HIGHLANDS: California, Univ., Pubs. Geol. Sci., v. 38, no. 1, 87 p., 14 illus., 7 maps, diag., 1960, 33 refs.

An imposing chain of Quaternary volcanoes lies between the coastal plain of Guatemala and a parallel belt of eroded late Tertiary volcanic and sedimentary rocks which, like coeval rocks in the adjacent republic of El Salvador, were laid down on land.

The rugged surface upon which the Tertiary deposits accumulated was cut chiefly in mid-Cretaceous plutons, Early Cretaceous limestones, and still older metamorphic rocks. Large volcanic cones did not develop until Quaternary time. During Miocene and Pliocene times, most eruptions took place from fissures. They produced an extensive plateau composed partly of lava flows but mostly of rhyolitic and dacitic pumiceous deposits laid down by glowing avalanches, interbedded with thick sheets of fluviatile, tuffaceous sediments and a few lenses of diatomite.

In late Pliocene time and subsequently, the Tertiary rocks were gently folded and broken by many faults. In the eastern part of the highlands, most of the faults, including those that border the Guatemala City graben, trend approximately N.-S.; elsewhere, most of the faults trend approximately E.-W. or NE.-SW.

The Quaternary volcanoes are mostly composite cones of pyroxene andesite that bear only a few parasitic cones of basaltic cinders on their flanks. However, many of the volcanoes during their later stages of growth discharged immense volumes of dacitic pumice from their summit vents, and some of them erupted domes of viscous andesite and more siliceous lavas far down their slopes.

The flat-floored valley of Quetzaltenango is deeply filled with Recent deposits of pumice left by glowing avalanches that swept down from the crater of Siete Orejas volcano and from a vent near Totonicapán. Some of the flat-topped deposits of pumice that fill the valleys between Tecpán and Chimaltenango are also products of glowing avalances, as some of those near Chichicastenango and Quiché and some of those in the Guatemala City graben. But most of the pumice deposits that form flat-floored valleys in the Guatemalan highlands were laid down by streams and torrential floods (lahars) which stripped airborne pumice falls from the surrounding hills. The earliest pumice in the valleys between Tecpán and Chimaltenango is at least 16,000 years old; the youngest pumice in the Guatemala City graben was deposited before the oldest (Las Charcas) phase of the pre-Classic culture of Kaminaljuyu - more than about 2,340 years ago.

The huge oval basin that holds the beautiful lake Atitlán is not a caldera but a cauldron formed by collapse as a result of subterranean withdrawal of magma. Part of the basin has continued to subside as a result of Recent eruptions of the lakeside volcanoes of Atitlán, Tolimán, and San Pedro. On the other hand, the basin holding lake Ayarza, which is shaped like the figure 8, is a caldera of Krakatoan type, formed when the tops of 2 volcanic cones collapsed into an underlying magma chamber as it was drained, chiefly by voluminous eruptions of pumice. Finally, lake Amatitlán, which lies between the southern end of the Guatemala City graben and the northern base of the volcanic complex of Pacaya, is a volcano-tectonic basin; its irregular form was produced by collapse along lines of tectonic weakness, presumably during eruptions of the volcano Pacaya.--Auth.

**3-593.** Osmundsen, John A. ANTARCTIC HEARS OF A 2D VOLCANO: New York Times, v. 110, no. 37,600, p. 26, col. 6, Jan. 3, 1961.

A helicopter pilot reported steam issuing from Mount Terror, a 10,148-ft. peak 30 mi. from the base at McMurdo Sound. Mount Erebus, 18 mi. from the reported activity, is the only previously known active volcano in Antarctica.--M. Russell.

**3-594.** Walker, George P. L. ZEOLITE ZONES AND DIKE DISTRIBUTION IN RELATION TO THE STRUCTURE OF THE BASALTS OF EASTERN ICELAND: Jour. Geology, v. 68, no. 5, p. 515-528, 4 maps, 2 secs., Sept. 1960, 18 refs.

Amygdale minerals in the Tertiary basalt lavas of eastern Iceland have a well-marked zonal distribution; the flat-lying zones mapped in the field bear no relationship to the lava stratigraphy and are inferred to be approximately parallel to the original top of the lava pile. An independent method of deducing the position of this is available, depending on the fact that the intensity of the Tertiary dike swarm in the area everywhere diminishes upward; extrapolation gives the altitude of zero intensity, which is in good agreement with the altitude of the original top of the lavas deduced from the mineral zones. Both support the observation that the lavas thin up-dip, and the implications of this on the interpretation of the structure and geology of Iceland are discussed. --Auth.

**3-595.** Nemoto, Tadahiro. **IGNEOUS ACTIVITY IN THE CHISHIMA (KURILE) ISLANDS. Translated by Kinkiti Musya: Internat. Geology Rev., v. 2, no. 12, p. 1047-1052, 5 tables, Dec. 1960, 22 refs.**

The Chishima islands are composed mainly of Neogene and Quaternary volcanics. Two cycles of volcanic activity are evident, a Miocene to Pliocene cycle and a Quaternary cycle, the break being marked by a period of crustal movement when the island arc was broken into 3 blocks now separated by deep channels. Volcanism in the northern and southern blocks is similar to the adjacent Kamchatka and Hokkaido regions, while the middle block is characteristic of oceanic facies. A shift in rock type from generally acidic to generally basic is evident within each volcanic cycle.--M. Russell.

**3-596.** Hamilton, Warren B. **FORM OF THE SUDBURY LOPOLITH: Can. Mineralogist, v. 6, pt. 4, p. 437-447, map, diag., secs., table, 1960, 17 refs.**

The mutual concordance of the various elements of the Sudbury lopolith, Ontario, and the overlying sedimentary rocks, and the gravity data, indicate the complex to be essentially a folded double sheet of granophyre above norite. The lopolith lies with complete discordance upon plutonic and metamorphic rocks of complicated structural and metamorphic history, and is overlain concordantly by rhyodacite tuffs which are intruded by the granophyre and are in turn overlain concordantly by sedimentary rocks. The granophyre ("micropegmatite") and the overlying tuffs are strongly alkaline, and share the distinctive chemical composition - low $Al_2O_3$ and CaO, high Fe - that characterizes lopolith-cap rocks elsewhere. The tuffs may be the true cap of the complex, which may have been essentially extrusive in origin.

The norite of the lopolith is unlayered and contains abundant interstitial micropegmatite, and is like the upper parts of other great lopoliths. The Sudbury basin may contain only an overflow part of the N. flank of a huge lopolith, the bulk of which has been removed by erosion and which contained the missing mafic and ultramafic differentiates.--Auth.

**3-597.** Thornton, Charles P., and O. Frank Tuttle. **CHEMISTRY OF IGNEOUS ROCKS. I. DIFFERENTIATION INDEX: Am. Jour. Sci., v. 258, no. 9, p. 664-684, diags., graph, Nov. 1960, 25 refs.**

Recent experimental studies corroborate the evidence Bowen used in 1937 to demonstrate that fractional crystallization of complex magmas produces liquids which move toward and, for all practical purposes, eventually reach the system $SiO_2$-$NaAlSiO_4$-$KAlSiO_4$, petrogeny's residua system. In a volcanic rock series the distance a given magma has travelled toward this goal can be quantitatively measured by calculating the norm and summing the constituents of petrogeny's residua system; this value is called the differentiation index. It is a useful coordinate for variation diagrams and is a measure of the "basicity" of a rock.

A series of frequency distribution diagrams have been prepared from 5,000 analyses in Washington's Tables. Using these diagrams, any rock analysis can be compared at a glance with all the analyses and any deviations from the "average" can readily be seen.--Auth.

**3-598.** Rogers, John J. W., and John D. Longshore. **DIFFERENTIATION OF A LAMPROPHYRE SILL, NORTHERN LA PLATA MOUNTAINS, COLORADO: Am. Mineralogist, v. 45, no. 7/8, p. 774-782, 4 illus., 6 diags., July-Aug. 1960, 8 refs.**

Differentiation trends in a lamprophyre sill in the northern La Plata Mountains indicate fractional crystallization of an originally sodic melt containing pyroxene phenocrysts and inclusions of amphibolitic rock. Injection and fairly rapid crystallization caused the abundance of pyroxene to remain approximately constant throughout the sill. Fractional crystallization, however, resulted in an increase in the amount of plagioclase toward the center of the sill and a concurrent increase in albite content of the plagioclase. Selectively greater resorption of the amphibolite inclusions toward the center of the sill caused the percentage of hornblende to decrease inward from the margins, for the hornblende in the sill has been derived entirely from digestion of the inclusions and was out of equilibrium with the melt. Extensive late-stage activity involved formation of chlorite, argillization of plagioclase, and development of minor calcite and thomsonite.--Auth.

**3-599.** Foster, Robert J. **ORIGIN OF EMBAYED QUARTZ CRYSTALS IN ACIDIC VOLCANIC ROCKS: Am. Mineralogist, v. 45, no. 7/8, p. 892-894, July-Aug. 1960, 7 refs.**

Some "corroded" quartz in acidic volcanics originates as xenocrysts from the wall rock or as amoeboid growth in a viscous melt. The embayment of dipyramidal crystal forms and fragments of crystals shattered during the high to low inversion suggest, in the light of Tuttle and Bowen's work, a reaction between quartz and solidified groundmass due to a late liquid phase or an intergranular film.--D.O. Emerson.

**3-600.** Tomita, Tōru. **CHEMICAL DISTINCTIONS BETWEEN THE THREE PRINCIPAL SERIES OF BASALTIC ROCKS. Translated by Reiko Fusejima: Internat. Geology Rev., v. 2, no. 11, p. 967-982, 12 diags., Nov. 1960, 32 refs.**

A new diagram to permit analysis of the chemical composition and genesis of basalts is proposed, the $\underline{\text{wo-fo-Q}}$ diagram. Three major series of basalts are distinguished: alkaline rock series, tholeiitic rock series, and contaminated rock series. The Mauna Loa-Kilauea basalts and the Mull-Antrim basalts are both tholeiitic but differ in evolution. Basalts of Rishiri Island, Oshima-Ooshima in Hokkaido, and the Izu Islands are of the acid tholeiitic series, those of Izu peninsula and Fuji volcano are of basic tholeiitic series. The Izu-Hakone "parental magma" of Kuno differs from typical tholeiitic basalt. Indo-Chinese Cenozoic basalts are of the contaminated rock series. "Tholeiitic basalts" of northern Kyushu are probably of the contaminated series.--M. Russell.

3-601. Compton, Robert R. CHARNOCKITIC ROCKS OF SANTA LUCIA RANGE, CALIFORNIA: Am. Jour. Sci., v. 258, no. 9, p. 609-636, illus., 2 maps, sec., 2 tables, Nov. 1960, 17 refs.

Certain tonalites of the broad crystalline core of Santa Lucia Range differ from the far more abundant normal granitic rocks of the region in that they are dark colored, invariably allotriomorphic, and consist largely of antiperthitic andesine, hypersthene, hastingsitic hornblende, ilmenite, and garnet. K-Ar determinations indicate the normal granitic rocks are Cretaceous, and there is moderate evidence that the charnockitic rocks formed in an earlier stage of the same plutonic cycle. The principal charnockitic pluton is intrusive, but the recrystallization of thin basic dikes that cut it shows that it acquired its charnockitic characters by late-igneous or subsequent processes. The metamorphic country rocks (Sur series) are of amphibolite facies elsewhere in the region, but they have been converted to granulite-facies assemblages in and locally near the pluton, whereas veins with granulite-facies minerals that formed at the same time as the pluton are not only concentrated around it but are typically less hydrous than the rocks in which they occur. The close genetic relation of these various rocks is indicated by the persistence of mineral species in rocks of various compositions, by the narrow range (1.0-1.2) of Fe/Mg in all the mafic minerals except garnet, and by the abnormally high values of Na/K and $Fe''/Fe'''$ in both the pluton and the veins. The coarse-grained nature of the veins, the widespread occurrence of fracture-controlled alterations, and the appreciable metasomatism affected during the formation of the veins all indicate that the charnockitization was produced by fluids that passed through the solidified part of the pluton and out into the country rocks, chiefly along fractures opened by the intrusion.--Auth.

3-602. Asano, Gorō. STRUCTURAL CONTROL OF IGNEOUS INTRUSION INTO COAL-BEARING FORMATIONS AND THEIR THERMAL METAMORPHIC ACTION. Translated by Reiko Fusejima: Internat. Geology Rev., v. 2, no. 11, p. 983-991, 5 secs., 2 tables, Nov. 1960, 4 refs.

Many sills and dikes intruded the southern half of the Chikuhō coal field in Kyushu, Japan. The mechanism of intrusion, petrology of the igneous rock, and thermal metamorphism of the coal were studied in the Ōminé and Shimoyamada mines. Sills selectively intrude only thick seams of coking coal. Two modes of sill intrusion are apparent: 1) flows of fluid magma freely following the plane of bedding before solidification, and 2) forced intrusions of solidified andesite which pulverized the coal in the seam as it progressed. The sills originated from magma rising along steeply dipping tension cracks caused by pressure of the magma chamber and now filled with dike rock. Areal folding and faulting preceded the intrusion of sills and dikes. The igneous rock is 2-pyroxene andesite containing saponite pseudomorphs of olivine. Thermal metamorphism has resulted in variations of coal ranging from semi-anthracite to natural coke.--M. Russell.

3-603. Bloxam, T.W. JADEITE-ROCKS AND GLAUCOPHANE-SCHISTS FROM ANGEL ISLAND, SAN FRANCISCO BAY, CALIFORNIA: Am. Jour. Sci., v. 258, no. 8, p. 555-573, 8 illus., 3 maps, 4 tables, Oct. 1960, 25 refs.

The rocks of Angel Island comprise a series of Franciscan (Jurassic) arkosic graywackes with subordinate amounts of conglomerate and radiolarian chert. Almost all the graywackes have been metamorphosed to jadeite-bearing metagraywackes independently of proximity with basic or ultrabasic intrusions. A diabase sill, originally intrusive into the sedimentary series, has also been metamorphosed and its feldspar converted to chlorite, lawsonite, and jadeite. Glaucophane occurs in the altered diabase and is particularly abundant at its margins. Towards the diabase the jadeite-bearing metagraywackes become richer in glaucophane and pass into jadeite-free schistose glaucophane-rocks. Chemical analyses show that the change is accompanied by some desilication and an addition of Fe, Mg, Ca, Ti, and possibly Na. This metasomatism, which may have preceded, or coincided with, the metamorphism, was probably hydrothermal in nature and localized along igneous contacts and shear-planes. Similar, but more extensive developments of glaucophane-schist, also derived from graywacke, occur in association with a dike of serpentinized pyroxenite. Hydrothermal processes directly related to the serpentinization may have played a significant part in the chemical alteration of the graywacke. Movements along serpentinite contacts complicates the relationships, and many large masses of glaucophane-schist and jadeite-bearing metagraywacke occur as tectonic inclusions within the serpentinite. Plagioclase is absent from, and considered unstable in, all the metamorphic assemblages. While jadeite appears to be stable in the arkosic metagraywackes deficient in Fe, Mg, and Ca; its place is taken by acmitic-jadeite and eventually glaucophane in the glaucophane-schists.--Auth.

## 10. SEDIMENTARY PETROLOGY

See also: Engineering Geology 3-648.

3-604. Van Houten, Franklyn Bosworth. COMPOSITION OF UPPER TRIASSIC LOCKATONG ARGILLITE, WEST-CENTRAL NEW JERSEY: Jour. Geology, v. 68, no. 6, p. 666-669, 3 figs. incl. map, table, Nov. 1960, 6 refs.

The upper Triassic Lockatong formation consists principally of hard massive gray to reddish-brown argillite and black shale and platy thin-bedded mudstone. The predominant minerals in the massive argillite which contains as much as 7% soda and as little as 47% silica, are analcime, dolomite, feldspar, and a 10 Å micaceous clay mineral. Quartz is very rare or absent. In the platy and shaly beds analcime is rare; dolomite, micaceous clay minerals, and feldspar are abundant; and scattered pyrite is common. Metamorphic effects of a diabase sill were restricted largely to converting poorly crystalline micaceous clay to well-crystallized biotite, analcime to albite, dolomite to calcite, and pyrite to pyrrhotite.--Auth.

3-605. Harbaugh, John W. PETROLOGY OF MARINE BANK LIMESTONES OF LANSING GROUP (PENNSYLVANIAN), SOUTHEAST KANSAS: Kansas, State Geol. Survey, Bull. 142, pt. 5, p. 189-234, illus., maps, secs., diags., 3 tables, 1960, 23 refs.

Limestones of the Lansing group in the Wilson-Montgomery County, Kansas, area contain small patches of coarsely crystalline calcite that exhibit 2 types of fabric, one formed by precipitation of calcium carbonate in cavities; the other by recrystallization of carbonate silt or fine skeletal debris by a process termed grain growth.

Filled cavities are associated with leaflike fragments of algal crusts, which, during deposition, served as umbrellas, catching carbonate silt and skeletal debris on their upper surfaces and maintaining sheltered open spaces beneath. Cavities also were formed between fragments of partly consolidated carbonate silt that formed sedimentary breccias.

Algal crusts and fragments of other organisms tended to accumulate in thickened lenses or banks, which rose above the level of the surrounding sea floor and extended over many square miles. The banks were seemingly too poorly consolidated initially to have formed wave-resistant reefs.

Solution pores in Lansing limestone specimens obtained at outcrops show that small-scale lithologic features have exerted a large effect in localizing pores. Many pores occur within coarsely crystalline mosaics, particularly those formed as open-space precipitates. Other pores are localized at the boundaries of mosaics, at the contacts between individual skeletal particles, within algal crusts, and within dolomitized patches. Fractures, both large and small, also have had large influence in localizing pores. Development of porosity in buried Lansing limestones that serve as oil-reservoir rocks may be influenced similarly.--Auth.

**3-606.** Newell, Norman D., and others. **BAHAMIAN OÖLITIC SAND:** Jour. Geology, v. 68, no. 5, p. 481-497, 16 illus., map, profile, graph, 3 tables, Sept. 1960, 27 refs.

Deposits of oölitic aragonite sand are being formed in a discontinuous belt in very shallow waters along the margins of the Great Bahama Bank. In a studied area S. of Bimini, there is strong negative correlation between water depth and oölitic structure of the grains suggesting that waters less than 6 ft. deep are optimal for oölite formation. The largest percentage of oölitically coated grains, and the grains with the greatest number of lamellae are concentrated in, and just below, the intertidal zone, where they are in contact with sea water judged to be supersaturated (metastable) with respect to aragonite. The metastable condition is believed to result from the fact that tidal flow over the barrier rim of the shelf lagoon brings relatively cool, $CO_2$-rich water into a shallow, heated, turbulent zone so rapidly that organic extraction of calcium carbonate does not keep pace with the increase in carbonate saturation due to $CO_2$ loss.

Each oöid consists of a nucleus, usually an abraded shell fragment or a recrystallized fecal pellet, surrounded by a concentrically laminated envelope, which may range in size from a thin, superficial coating to a layer comprising seven-eighths of the volume of the grain. Grains with a thick, laminated envelope tend to be subspherical or ellipsoidal. Grains with few layers may be any shape, depending on the form of the nucleus. The distinctive and environmentally significant feature of these grains is judged to be the laminated layer. Consequently, the term "oöid" is here used for grains displaying this structure, regardless of the shape. "Oölite" refers to aggregates of oöids.

The concentric lamination of the envelope is due to the presence of distinct, relatively unpigmented, lamellae which are regular in thickness (about 1 to 3$\mu$) and composed of submicroscopic crystals of aragonite with c-axes oriented tangential to the lamination. In addition to these oriented aragonite lamellae the envelope contains unoriented cryptocrystalline aragonite, generally more heavily pigmented and occurring both as discontinuous layers and lenses intercalated between oriented aragonite lamellae and as irregular blebs transecting the concentric structure. A fabric seemingly identical to that of the unoriented cryptocrystalline aragonite of the envelope occurs also in pellet nuclei and in recrystallized skeletal grains. Thus the unoriented fabric is at least in part demonstrably a product of recrystallization, but it may in part result from interstitial precipitation.

The grains contain much organic matter, which occurs both as perforating filamentous algae and as a gelatinous substance resembling organic detritus and tending to concentrate in the unoriented aragonite.

It is concluded that the oriented lamellae represent grain growth by the addition of aragonite at the grain surface as a physicochemical precipitate. The unoriented aragonite is believed to result from interstitial recrystallization (and possibly precipitation) associated with organic matter incorporated in the grain 1) as the organic fraction of a fecal pellet, 2) as an adherent film of organic detritus, and 3) as remains of boring algae.--Auth.

## 11. GEOHYDROLOGY

See also: Areal and Regional Geology 3-435.

**3-607.** Griffin, Margaret S., and Evelyn N. Clark, comps. **BIBLIOGRAPHY OF TECHNICAL REPORTS, ARTICLES, AND MEMORANDA PUBLISHED OR OTHERWISE RELEASED BY THE GROUND WATER BRANCH DURING THE CALENDAR YEAR 1959:** U.S. Geol. Survey, Repts., Open-File Ser., 28 p., [1960].

This bibliography of approximately 340 references includes the papers prepared in the U.S. Geological Survey, Ground Water Branch that were published during 1959 and the papers that were transmitted to the Director or to a cooperating state agency for publication, the papers presented at meetings of technical societies or submitted to technical journals, and those released in typewritten or duplicated form. Essentially most of the papers were prepared in cooperation with state, county, and municipal agencies. Certain reports of other branches that contain sections on ground water are listed also. The bibliography covers the work of somewhat more than the period indicated, and the same paper may be listed in the bibliographies of 2 different years, first as having been transmitted for publication, and again as having been published.--From introd.

Papers are listed under 11 sections according to the form in which they were published or transmitted. They are listed alphabetically by author within the sections.

3-608. Heath, James P. **SALT- AND FRESH WATER RELATIONSHIPS IN TWO TERMINAL STREAM BARS: Am. Jour. Sci., v. 258, no. 8, p. 605-607, table, Oct. 1960, 3 refs.**

Salt water even more concentrated than sea water was found in the terminal bars of 2 California streams. There was evidence of movement of the fresh water beneath this.--Auth.

3-609. Krieger, R.A., and G.E. Hendrickson. **EFFECTS OF GREENSBURG OILFIELD BRINES ON THE STREAMS, WELLS, AND SPRINGS OF THE UPPER GREEN RIVER BASIN, KENTUCKY: Kentucky Geol. Survey, Ser. 10, Rept. Inv. 2, 36 p., 13 figs. incl. 7 maps, diags., graphs, 7 tables, 1960, 7 refs.**

Water-quality studies based on daily sampling of the Green River at Munfordville, Kentucky, from Oct. 1950 through Sept. 1959 provided a continuous record on which to measure the effect of waste brines from the Greensburg oilfield. Before Aug. 1958, the Green River water was of the calcium magnesium bicarbonate type and had an average chloride concentration of less than 10 p.p.m. (parts per million). With the disposal of brines coincident with the rapid development of the Greensburg oilfield in the spring of 1958, the water changed to a sodium chloride type and chloride concentrations frequently exceeded 1,000 p.p.m. Hardness also increased greatly so that domestic and industrial use of the Green River has been affected. While oil production has declined steadily, waste brine production has remained high. The Green River at Munfordville discharged 305,000 tons of chloride in the 1959 water year compared to 10,600 tons in 1957.

Brines discharged from oil wells in the Greensburg oilfield have contaminated the water supplies from a number of wells and springs in the upper Green River basin. Ground-water contamination is concentrated in the areas of heavy brine production in Green and Taylor counties but is noticeable as far away as Brownsville, about 100 mi. downstream from the area of greatest oil production. The 2 large springs known as Echo River and Styx River at Mammoth Cave, about 20 mi. upstream from Brownsville, also have been contaminated.--Auth.

3-610. O'Rear, David M. **GROUND-WATER LEVELS IN ALABAMA IN 1957 AND 1958: Alabama, Geol. Survey, Inf. Ser. no. 19, 81 p., 4 maps, 24 graphs, table, 1960, refs.**

Water-level data were collected from 33 observation wells. Basic information is given for each well with a tabulated list of the daily lowest water level obtained from the recorder graphs or from periodic tape measurements. Hydrographs comparing water-level fluctuations with local precipitation for 1954 through 1958, were constructed for each well and are included in the report. The precipitation is shown by means of bar graphs and is the total recorded for each month of the 5-year period. Precipitation in Alabama is generally heaviest in the late winter and early spring. This is the period of maximum recharge to the ground-water reservoir.

Geologically, Alabama may be divided into the Piedmont, Paleozoic, and Coastal Plain areas. The Piedmont area is underlain by metamorphic schist and gneiss into which younger igneous rocks have been injected. Wells in this area generally do not yield more than 50 g.p.m. (gallons per minute); however, in some parts of the Piedmont large quantities of ground water are obtained from beds of limestone, marble, and dolomite. In northern Alabama, Paleozoic formations of sandstone, limestone, chert, and dolomite are important sources of ground water. About 75% of the municipal and industrial supplies and practically all of the private water supplies are obtained from these rocks. Wells yielding 200 g.p.m. are fairly common in this area, and some wells yield as much as 1,000 g.p.m. The Coastal Plain area of Alabama is underlain by extensive beds of clay, marl, chalk, and limestone. The beds slope regionally toward the S. and SW. Artesian wells in this area supply plentiful amounts of water of relatively low temperature and usually acceptable quality. The wells are the chief source of water supply for nearly all municipalities, industries, and private users; yields of 500 g.p.m. are common, and many wells yield more than 1,000 g.p.m.--L.M. Dane.

3-611. Warman, James C., and others. **GEOLOGY AND GROUND-WATER RESOURCES OF CALHOUN COUNTY, ALABAMA: Alabama, Geol. Survey, Inf. Ser. 17, 67 p., 3 maps (1 in pocket), 2 tables, 1960, 7 refs.**

A study of the geology and ground-water resources of Calhoun County in northeastern Alabama was begun in July 1956 by the U.S. Geological Survey in cooperation with the Calhoun County Board of Commissioners, the city of Anniston, and the Geological Survey of Alabama.

Data were collected from 996 wells and springs in Calhoun County. The county is underlain by rock formations that have been folded and thrust faulted. The fault zones form reservoirs for large quantities of ground water. Abundant supplies are available also from several of the rock formations - the Shady dolomite [Cambrian], Rome shale [Cambrian], Conasauga formation [Cambrian], and Cambrian or Ordovician dolomite. These formations are relatively thick and have great areal extent. The Fort Payne chert [Mississippian] and Newala limestone [Ordovician] also furnish abundant supplies of ground water, but these formations are not so extensive in their areas of outcrop. The quality of the ground water is generally good, except for water from the Conasauga formation, which is hard, and water from the Floyd shale [Mississippian], which is very hard and contains excessive amounts of Fe.--Auth.

3-612. LaMoreaux, P.E., and Lyman D. Toulmin. **GEOLOGY AND GROUND-WATER RESOURCES OF WILCOX COUNTY, ALABAMA: Alabama, Geol. Survey, County Rept. 4, 280 p., 24 illus., 4 maps (3 in pocket), 2 charts, 27 secs., 4 diags. (1 in pocket), 2 graphs, 4 tables, 1959, approx. 200 refs.**

Subsurface geologic formations important to the occurrence of ground water in the area include the Demopolis chalk, Mooreville chalk, and Eutaw formation [all Upper Cretaceous]. A contour map of the top of the deposits of Late Cretaceous age indicates the geologic structure and its relation to the movement of ground water.

Formations exposed in Wilcox County range in age from Late Cretaceous to Recent. The regional dip of the strata is to the S. and SW. about 35 ft. per mi., except locally where there are abnormal structures. Formations mapped and described in detail include the Ripley formation and Prairie Bluff chalk of the Upper Cretaceous series; the Clayton, Porters Creek, and Naheola formations of the Paleocene series; the Nanafalia formation, Tuscahoma sand,

and Hatchetigbee and Tallahatta formations of the Eocene series; terrace deposits of Pleistocene age; and alluvial deposits of the Recent streams.

Important aquifers yielding water to wells in the area include the sand beds of the Eutaw formation in the northern quarter, sand beds of the Ripley formation in the eastern, northern, and central parts, sandy limestone beds of the Clayton formation in the eastern part, sand beds of the Nanafalia formation and Tuscahoma sand in the southern part, and sand and gravel beds in terrace deposits and alluvium along the major drainage and tributary streams of Wilcox County.

In favorable areas the aquifers of the Eutaw, Ripley, and Nanafalia formations are capable of yielding 250 g.p.m. (gallons per minute), and in some areas as much as 1,000 g.p.m., to individual wells. For example, natural flows of 100 g.p.m. from wells in the Nanafalia formation are obtained in the lowland areas in the southern part of the county. This formation supplies as much as 900 g.p.m. to individual wells in Monroe County, immediately S. of the area of this report. Sand and gravel beds of the terrace deposits and alluvium, where present in adequate thickness along perennial streams of the area, are a potential source of large quantities of water.

In general, ground water in Wilcox County is of good quality, being relatively soft and low in chloride and dissolved solids. The mineral content of the water increases to the S. and SW. with increasing depth of the aquifer. For example, the chloride content of water from the Eutaw formation increases progressively southward from Alberta and Catherine. The chloride content is high also in water in formations that are disturbed by faulting and folding, as, for example, the Tuscahoma sand and Nanafalia formation near a fault that extends northwestward from the vicinity of Coy to Pine Hill. In general, ground water in the county is soft, having a hardness of less than 50 p.p.m. (parts per million). The temperature of the ground water ranges from 54° to 98°F. according to the depth and location of the wells.--Auth.

**3-613.** Reeder, H.O., and others. **CHANGES IN WATER LEVELS IN 1955 AND ANNUAL WATER-LEVEL MEASUREMENTS IN JANUARY AND FEBRUARY 1956 IN OBSERVATION WELLS IN NEW MEXICO: New Mexico, State Engineer Office, Tech. Rept. 16, 145 p., 27 maps, 5 graphs, 16 tables, 1960, 36 refs.**

This report tabulates the annual measurements of water level in about 1,490 observation wells in the various areas in Jan. or Feb. 1956 with changes in water level in 1955, and includes discussion and maps of change of water level for 1955 for each area in which observations are being made.

The areas of observation included in this report are House, Clovis, Portales Valley, Tatum-Lovington-Hobbs, Roswell basin, Carlsbad, Estancia Valley, Tularosa-Alamogordo, Hot Springs basin, Grants-Bluewater, and Animas, Playas, Virden, and Mimbres valleys.

Additional related data collected in connection with the observation-well program for the various areas include acreage irrigated with ground water, pumpage, and precipitation data. It is estimated that about 870,000 acres of land was irrigated in 1955 in New Mexico of which 450,000 acres was irrigated entirely with ground water and 135,000 acres was with a combination of ground water and surface water.

The year 1955 was the sixth consecutive year of general below normal precipitation. However, the distribution and timing of the precipitation were more favorable for agricultural purposes, making the 1955 growing season one of the best in several years. Because of the favorable precipitation, less ground water was applied to the land in 1955 than in 1954, so that there was a decrease in total pumpage in spite of the increase of irrigated acreage. It is estimated that in 1955 about 1,240,000 acre-ft. of ground water was pumped.

Water levels continued to decline in 1955 in most areas where ground water was used for irrigation. In general, the declines were greater than in 1954 in the southwestern part of the state and smaller in the eastern and southeastern parts, where some rises were noted. Appreciable rises were noted in the Carlsbad area.--Auth.

**3-614.** Gordon, Ellis D. **GEOLOGY AND GROUND-WATER RESOURCES OF THE GRANTS-BLUEWATER AREA, VALENCIA COUNTY, NEW MEXICO. With Sections On Aquifer Characteristics by H.O. Reeder, and Chemical Quality of the Ground Water by J.L. Kunkler: U.S. Geol. Survey, Repts., Open-File Ser., 224 p., 6 illus. (in pocket), 4 maps (in pocket), 7 graphs (in pocket), 12 tables, 1960, 79 refs.**

Ground water has been developed extensively for irrigation and industrial use in the Grants-Bluewater area of N.-central Valencia County, an area in or near which are about two-thirds of the nation's known U reserves. The development of ground water has created many problems; this report appraises the problems and their causes.

The principal aquifer in the area is formed by the Glorieta sandstone [Permian] and the overlying San Andres limestone [Permian], which crop out on the flanks of the Zuni Mountains and underlie the eastern two-thirds of the area. Interbedded alluvium and basalt of Quaternary age form an aquifer of secondary importance.

The Glorieta sandstone is less permeable than the San Andres, and few wells tap it exclusively. The Glorieta transmits water to the overlying San Andres limestone, however, as pumping decreases the hydraulic pressure in the San Andres. Well-connected cavernous zones and solution channels have developed in the San Andres, and the transmissibility of the limestone is great in most places.

The alluvium and basalt yield adequate quantities of water for stock and domestic use at most places and for irrigation and municipal use locally.

The first irrigation well was drilled in 1944, and the number had increased to 23 in 1951. The use of ground water for irrigation reached a peak of 12,600 acre-ft. in 1954 and has since decreased. Several of the irrigation wells have been converted for industrial and municipal supply, and ground water for these uses increased from 250 acre-ft. in 1951 to 6,000 acre-ft. in 1957. The total withdrawal stabilized at about 13,000 acre-ft. per year from 1950 to 1957.

Withdrawal of ground water has caused water levels to decline 40 to 45 ft. N. of Bluewater Village and 18 to 20 ft. from Bluewater Village SE. to near Grants.

The largest yields are obtained from wells penetrating both of the major aquifers in the southwestern part of the Grants-Bluewater Valley between Bluewater Village and Milan. The yields of wells in that area range approximately from 500 to 2,200 g.p.m. (gallons per minute); the specific capacities of the wells that were measured averaged 200 g.p.m. per ft. of drawdown. The specific capacity of only one well that taps the alluvium and basalt was determined; it was 31 g.p.m. per ft. of drawdown.

The chemical quality of the water in both aquifers varies widely in short distances. The quality of water yielded by a few wells that tap the San Andres limestone has changed in the last decade; some water has improved in quality and some has deteriorated, according to the proximity of the recharge area. The agricultural utility of water from both aquifers generally is satisfactory, although the salinity hazard of water in some areas is high. Water used for the municipal supply of Grants is too hard and too saline to be desirable, and the sulfate concentration is high enough to impart an objectionable taste to the water. The water of best chemical quality is obtained from both aquifers between Bluewater Village and Milan, where the largest average yields also are obtained.--Auth.

**3-615.** Hood, James W., and others. **THE OCCURRENCE OF SALINE GROUND WATER NEAR ROSWELL, CHAVES COUNTY, NEW MEXICO:** New Mexico, State Engineer Office, Tech. Rept. 17, 93 p., 16 maps, sec., graphs, table, 1960, 11 refs.

The Roswell basin in the Pecos River valley of southeastern New Mexico is semiarid, and irrigation is required to grow crops. Surface-water supplies are insufficient to meet irrigation needs, and most of the water for irrigation is pumped from the ground-water reservoir. Ground water is developed principally from 2 aquifers: the aquifers in the San Andres limestone under artesian pressure and the aquifer in the alluvium under water-table conditions.

The first wells to supply water for irrigation were drilled in the early 1900's, and the artesian aquifer was developed extensively before shallow-water pumping was begun. Artesian waters essentially were calcium sulfate waters, except in the immediate vicinity of the Pecos River and eastward, prior to large-scale pumping. The analyses of water from 10 irrigation wells W. of the Pecos River during the early days of irrigation showed a range in chloride content of water from 69 p.p.m. (parts per million) to 287 p.p.m. As pumping continued, the chloride content of water in artesian wells between Roswell and the river increased. By 1958 the chloride content of the water in wells ranged from 500 p.p.m. near the eastern limits of Roswell to more than 5,000 p.p.m. near the Pecos River E. of Roswell. The high concentration of chloride in many well waters required the abandonment and plugging of some wells. It appeared that sodium chloride waters were encroaching in the pumped area of the artesian aquifer near Roswell and threatening the continued use of artesian wells for irrigation water in that area. The sodium chloride content of the water in the shallow aquifer increased only slightly, and the problem appeared to be minor, except in a few small areas.

The problem of salt-water encroachment and ways of combating further encroachment were studied. Most of the project time was spent in collecting and analyzing water from wells throughout the irrigated area and near the Pecos River in order to define areas contaminated by salt water, to define the source and causes of movement of the salt water.

The artesian aquifer tapped by irrigation wells is in the upper part of the San Andres limestone of Permian age. The lower part of the San Andres is considerably less permeable and offers resistance to the upward movement of brine from the underlying formations. Although available data are inconclusive, it is believed that upward movement of water from depth contributes less to the salinization of water within reach of wells in the San Andres than does lateral migration of saline water. The pattern of encroachment indicates that saline waters are moving westward within the San Andres from the vicinity of the Pecos River. Artesian waters moving into the project area from the N. along the Pecos River are moderately to very saline. Waters in the San Andres E. of the Pecos River are "stagnant," very saline waters and brines. Both of these sources are near the project area, and the water is susceptible to movement toward the irrigation wells when pumping lowers artesian pressures.

Maps have been prepared showing areas in which wells pump fresh or saline water. Areas where wells yield water having chloride concentrations greater than 500 p.p.m. are referred to as saline-water areas or saline areas. This does not mean that in saline areas the artesian aquifer in the San Andres is saturated with saline water. The water pumped from a well is a mixture of water from all the water-bearing beds tapped by the well. A well can be pumping fresh water (less than 500 p.p.m. of chloride) from beds at shallow depth in the aquifer and saline water from beds at greater depths. The mixture discharged is fresh or saline, depending on the relative volume of water obtained from the fresh and saline sources. In well 11.25.8.422, drilled to 796 ft., one water-bearing zone between 418 and 447 ft. yielded water having a chloride content of 330 p.p.m.; water between 477 and 487 ft. had 835 p.p.m. and water between 595 and 796 ft. had 7,330 p.p.m. Data from this well and others indicate that the chloride content of water varies vertically as well as horizontally in the aquifer in the irrigated area.

In addition to a long-term deterioration, the quality of water fluctuates through a seasonal cycle of deterioration and improvement. The chloride concentration in well 10.24.35.222b in recent years has fluctuated seasonally through a range of more than 1,500 p.p.m., this being approximately the maximum seasonal change observed to date. The rapid deterioration caused by heavy pumping indicates that the source of chloride contamination is nearby.

Possible courses of action to stop the enlargement of the saline area are to: 1) pump a limited quantity of water from the saline source area; 2) reduce irrigation pumping from the artesian aquifer; 3) increase recharge in the intake area; and 4) salvage water now used nonbeneficially in the river-bottom area.--Auth.

**3-616.** Zaytsev, I.K. **PRINCIPAL TYPES OF HYDROGEOLOGIC STRUCTURES IN THE U.S.S.R.** Translated by Douglas C. Alverson: Internat. Geology Rev., v. 2, no. 12, p. 1085-1094, map, Dec. 1960.

Different parts of the U.S.S.R. are characterized by highly diverse hydrogeologic conditions which permit the distinction of a great number of hydrogeologic regions. The 2 principal types are artesian basins and hydrogeologic massifs. Artesian basins include platform and intermontane depressions. Hydrogeologic massifs, where fissure-vein ground waters prevail, are found in the crystalline shield areas. The basins and massifs are subdivided into groups depending on conditions of mineralization, temperature, and other specific features of the ground water. Thus, artesian basins are subdivided into those with fresh water, with salt water and brine, thermal waters, and those of permafrost ice. Hydrogeologic massifs include groups with cold carbonate and Rn waters, with thermal S-carbonate waters, with cold and thermal methane waters, and with hydrogen sulfide waters. The distribution of artesian basins and hydrogeologic massifs, and their subgroups, in the U.S.S.R. is given.--M. Russell.

3-617. Kurata, Nobuo. **OUTLINE OF THE GROUND WATER IN NORTH CHINA.** Translated by Chūzō Kondo: Internat. Geology Rev., v. 2, no. 12, p. 1078-1084, 3 tables, Dec. 1960, 34 refs.

Topics discussed include value of the ground water as a resource, general features of deep aquifers, and general features of native wells in China; also general features of shallow-seated ground water, including ground-water level and its seasonal fluctuations, 3 factors governing the quality of the ground water, characteristic features of the water in saline districts, pollution (in populated villages), areas where comparatively good water supplies can be obtained, and pH and temperature of the water.

## 12. MINERAL DEPOSITS

See also: Geologic Maps 3-379, 3-418; Geochemistry 3-528; Mineralogy 3-588, 3-589.

3-618. California, Division of Mines. **SAMPLING MINERAL DEPOSITS:** Its: Mineral Inf. Service, v. 13, no. 11, p. 1-7, Nov. 1960.

The article seeks to outline the basic philosophy of sampling mineral deposits and presents many problems that are encountered in sampling and the means of overcoming them. Sampling methods are outlined and their application to various forms and types of deposits is discussed.--P.K. Morton.

3-619. Watanabe, Takeo. **CHARACTERISTIC FEATURES OF ORE DEPOSITS FOUND IN CONTACT METAMORPHIC AUREOLES IN JAPAN.** Translated by Kinkiti Musya: Internat. Geology Rev., v. 2, no. 11, p. 946-966, fig., 3 tables, Nov. 1960, 104 refs.

In contact metamorphic aureoles developed mostly between Paleozoic and Mesozoic rocks and later intrusive masses, various kinds of ore deposits of pneumatolytic and hydrothermal origin are found. In calcareous environments many replacement deposits of Ca-Fe-skarn type occur commonly, while pneumatolytic to hydrothermal veins are found along fissures in noncalcareous sediments.

After explaining general features of the skarns found in contact-aureoles, modes of occurrence of metalliferous deposits of contact zones are described in detail. Thermal metamorphism of Mn deposits associated with siliceous sediments is also explained.--Auth.

3-620. Mero, John L. **MINERALS ON THE OCEAN FLOOR:** Sci. American, v. 203, no. 6, p. 64-72, 9 illus., 2 maps, diag., Dec. 1959.

The depths of the ocean are strewn with curious nodules rich in Mn, Cu, Co, and Ni. First described in the Challenger reports, they are now being studied for possible economic value. These nodules result from relatively complex electrochemical conditions in the sea, and the manganese oxides, at least, chemically resemble fresh water manganese ores. Three Pacific ore provinces are recognized wherein different relative percentages of the 4 main minerals and Fe occur; the Atlantic has less rich deposits. Estimates of the cost of recovery and processing seem to suggest economic possibilities in the Pacific. Other products from the sea floor might be the various sediments used for diatomaceous earth. Al and Cu ores, and portland cement. Phosphorite is probably mineable in economic quantities at present using drag dredges. Other possible techniques involve complex hydraulic dredges and vertical float hydraulic dredges; comparative costs are given. The problems of ownership and international law have yet to be clarified.--R.F. McAllister.

3-621. Smirnov, V.I., and L.M. Ryzhenko. **SOME SPECIAL FEATURES OF THE FORMATION AND DISTRIBUTION OF MERCURY DEPOSITS.** Translated by Paul T. Broneer: Internat. Geology Rev., v. 2, no. 12, p. 1029-1038, map, 3 tables, Dec. 1960.

This article briefly discusses the world distribution of Hg deposits. These are classified according to their associated minerals: Hg alone, Hg-Sb, Hg-As, Hg-Sb-As, Hg-Pb-Zn, and Hg-quartz-Au. The deposits are also categorized by the types of rocks in which they occur and by the geologic structures with which they are associated, i.e. (in beds at the crests of anticlinal structures, on the flanks of folds, and at the intersections of ore-bearing strata with faults; in thrust sheets and linear zones of fracturing; as veins within tectonic ruptures; and in local structures of varying origin). The metallogenic ages of the ore occurrences are grouped in 5 categories: Alpine (Tertiary and Quaternary), Mesozoic, Hercynian, Caledonian and older, and undetermined. Some details are given on the times of Hg mineralization in the history of the folded areas, the emplacement of the deposits in particular parts of folded systems, and on the extent of the deposits and the quality of the ores in them.--P.T. Broneer.

3-622. Robinson, S.C. **ECONOMIC URANIUM DEPOSITS IN GRANITIC DYKES, BANCROFT DISTRICT, ONTARIO:** Can. Mineralogist, v. 6, pt. 4, p. 513-521, map, 2 tables, 1960, 6 refs.

The geology and mineral deposits of the Bancroft U camp are reviewed briefly. The relation of the deposits of the one type that has been found to be economic to other types of deposits and to geological features is described. The mineralogy and geochemistry of the ore deposits is described. The ages of the ore deposits, of other mineral deposits, and of the principal igneous rocks of the district are compared. It is concluded that there is a genetic relationship linking the ore deposits to certain granite intrusives, and that the deposits were deposited in major part by replacement controlled by type of rock and structure, and in minor part by fissure filling.--Auth.

3-623. Cooper, Byron N. **PREPARATION OF IRON ORE CONCENTRATES OF COMMERCIAL**

**GRADE FROM IRON-BEARING SANDSTONE IN WESTERN VIRGINIA: Mineral Industries Jour., v. 7, no. 2, p. 1-5, map, June 1960.**

Virginia Fe ores reenter the realm of economic promise and possible utilization on a large scale as the result of field and experimental laboratory research work by the V.P.I. (Virginia Polytechnic Institute) Dept. of Geological Sciences under the Virginia Engineering Experiment Station, which have been financed largely by private industry. Important technological breakthroughs in the processing of low-grade Fe ores by V.P.I. geologists have uncovered the possibility for large-scale production of Fe-ore concentrates from the hematite-bearing sandstones in a localized area of mountain land near Pearisburg and Narrows, Virginia. Within a tract of about 11,500 acres, which constitutes a salient of the Jefferson National Forest, the dark-red sandstones of the Clinton formation crop out at the surface over extensive areas. Surface geologic studies indicate that quantities of raw material aggregating 300 to 400 million tons can be obtained by systematic quarrying without the stripping of any appreciable overburden. The Fe content of the sandstones ranges from 23 to 37%, which is notably higher than that of any other deposits of Clinton sandstone in western Virginia from which a large tonnage could be quarried.

Repeated tests show that an ore concentrate averaging 50% Fe can be produced from the raw sandstone by dry magnetic methods that utilize recently perfected types of magnetic separators. Material of this grade is entirely acceptable for feed in modern electric steel furnaces. The quantity of ore concentrate that could be produced from this particular deposit is estimated to exceed 150 million tons. The Fe-bearing sandstones cap extensive mountain slopes, which would facilitate inexpensive quarrying. The rocks are relatively soft and friable, and they crush readily into small pieces which grind down quickly into particles sufficiently small to free the hematite cement that holds the sand grains together. The preponderant part of the hematite is a highly crystalline variety that possesses unusually strong magnetic susceptibility. This unusual property is of major importance in the successful recovery of the hematite from the Fe-bearing sandstones by dry magnetic beneficiation. From 2 to 3 tons of raw material of average grade, one ton of ore concentrate averaging 50% Fe can be produced with approximately 80% recovery of the total available Fe.

Further exploration and testing of the deposit are needed to develop more information on the thickness and quality of the deposit in various parts of the 11,500-acre tract. This work will include 1) accurate surveying of the full extent of the deposit, 2) core-drilling the deposit to determine the thickness of quarriable ore in representative places, and 3) extraction of one or more bulk samples for further pilot-plant testing. Before these investigations can be made, prospecting and exploration permits must be obtained from the U.S. Bureau of Land Management by the parties interested in the possible utilization of the deposit.--Auth. summ.

**3-624. Chesnokov, B.V. RUTILE BEARING ECLOGITES FROM THE SHUBINO VILLAGE DEPOSIT IN THE SOUTHERN URALS. Translated by E.A. Alexandrov and Associates: Internat. Geology Rev., v. 2, no. 11, p. 936-945, 6 illus., diag., 7 tables, Nov. 1960, 22 refs.**

Rutile-bearing eclogites of Ti ore potential occur in crystalline schists of the M series near Shubino village in the southern Urals. They were formed by metamorphism of high-Ti igneous rocks. Retrogressive metamorphism is exhibited by the eclogites.--M. Russell.

**3-625. Mulligan, Robert. BERYLLIUM OCCURRENCES IN CANADA: Canada, Geol. Survey, Paper 60-21, 40 p., table, 1960, 16 refs.**

Short notes are given on more than 50 localities where Be minerals have been found in single occurrences or compact groups. Contains brief account of mineralogy, properties, and association of Be minerals. No deposits in Canada are being mined primarily for Be at present, but the report gives indications of relative potentialities of the various occurrences and supplements Canada, Geol. Survey, Map 1045-M2 (GeoScience Abstracts 1-1069).--P. Harker.

**3-626. Crowley, Frank A. COLUMBIUM - RARE-EARTH DEPOSITS, SOUTHERN RAVALLI COUNTY, MONTANA: Montana Bur. Mines & Geology, Bull. 18, 47 p., 8 maps, Aug. 1960, 19 refs.**

Carbonate-rich rocks in southern Ravalli County contain Nb and rare-earth minerals. Columbite and aeschynite are the principal Nb-bearing minerals, whereas ancylite, allanite, and monazite contain rare earths. The metallic minerals are sporadically distributed through the carbonate host rock.

The deposits occur in a NW.-trending band of pre-Beltian gneisses and schists and are localized predominantly within amphibolite layers. However, a few occurrences have been observed where rare-earth-bearing carbonates are in augen gneiss, quartz-plagioclase-biotite gneiss, and quartz-hornblende schist.

Several different groups of claims have been developed by underground workings and by surface pits. One small test lot of ore was shipped to the Government Purchasing Depot.

A discussion of economic aspects pertaining to the development of these carbonate bodies is included.--Auth.

**3-627. Williamson, D.R. THE SILLIMANITE GROUP: Colorado School Mines, Mineral Industries Bull., v. 3, no. 4, 11 p., 2 graphs, 6 tables, July 1960, 61 refs.**

The sillimanite group, including sillimanite, kyanite, andalusite, topaz, and dumortierite, is important to the metallurgical, glass, and ceramics industries as a source of the refractory aluminum silicate - mullite. Kyanite, because of its availability, has been the most important mineral in the group. Andalusite and dumortierite have been used to some extent. Certain unusual deposits of the remaining minerals have been exploited.

World reserves of sillimanite minerals are large and widely distributed. High grade reserves are, however, more restricted. Synthetic mullite, produced by fusing and sintering aluminous and siliceous material rather than by converting sillimanite-group ores, has become of major importance.

The geology of sillimanite group occurrences is presented in summary form with extensive bibliographic data.

A brief presentation is included relative to milling of the ores and preparation of mullite. Data are included on production, mining companies, and mullite manufacturers. Tables are included relating to the physical and chemical properties of the minerals and of mullite products.--W.C. Peters.

3-628. Hamlin, Howard P. EVALUATING CERAMIC CLAYS FOR POSSIBLE COMMERCIAL UTILIZATION: In: Kentucky Geol. Survey, Ser. 10, Rept. Inv. 3, p. 58-71, 7 tables, 1960, refs.

This report describes the general testing procedures and criteria used in making preliminary appraisals for clays for possible commercial utilization. The clays are classified according to use; brief summaries of the more critical properties as related to a particular use are given. Preliminary appraisals are valuable in that they indicate the use for which the clay is best suited, determine whether additional testing is warranted, and direct the course of specific testing that is required to make a complete evaluation.--Auth.

3-629. White, W. Arthur, and J.E. Lamar, comps. CERAMIC TESTS OF ILLINOIS CLAYS AND SHALES: Illinois State Geol. Survey, Circ. 303, 72 p., map, tables, 1960.

More than 125 ceramic tests of Illinois clays and shales, compiled from the files of the Illinois State Geological Survey, are presented to make available information regarding the ceramic properties of a wide variety of clays and shales in 59 counties.--Auth.

3-630. Parham, Walter E. LOWER PENNSYLVANIAN CLAY RESOURCES OF KNOX COUNTY, ILLINOIS: Illinois State Geol. Survey, Circ. 302, 19 p., map, 39 tables, 1960, 4 refs.

To determine the nature and uses of possible light-burning clay deposits of Knox County, Illinois, about 40 samples of the underclays below the Colchester (no. 2) coal were collected and tested.

Laboratory tests were made to determine the linear drying and firing shrinkage, water of plasticity, firing color, refractoriness, and bonding properties of the clay. The thickness of the clay, its overburden, and types of associated sediments were recorded from field observations.

The southern part of Knox County is the best area for clay prospecting. The thicker and lighter burning clays come from the SW. part of the county.--Auth.

3-631. Ives, William, and Walter E. Hill, Jr. OCCURRENCE AND BLEACHING PROPERTIES OF SOME KANSAS MONTMORILLONITE CLAYS: Kansas, State Geol. Survey, Bull. 142, pt. 4, p. 149-188, 3 maps, 11 tables, 1960, 19 refs.

Six deposits of clay, previously termed "bentonite," were examined and sampled for determination of their extent and quality. These deposits occur 1) in the Neogene Ogallala formation, 2) at the Neogene-Cretaceous unconformity, and 3) in Cretaceous shales. Laboratory analyses indicated the principal constituent of the clays to be Ca montmorillonite. Of 2 deposits in Clark County, one has estimated reserves of 500,000 tons and the other 1,200,000 tons. Examination of an occurrence in Graham County indicates little economic potential. The Long Island region of Phillips County has 12 known exposures of clay and may contain large deposits but is currently under lease. Three deposits are known in secs. 9, 10, and 11, T. 1 S., R. 18 W., Phillips County. The probable reserves in sec. 10 are estimated at 2,200,000 tons and in sec. 11 at 3,700,000 tons. A large area in Wallace County shows scattered exposures of clay, but delineation of distinct deposits was not possible.

Thirteen clay samples from these deposits were tested to ascertain relative bleaching power. Several different oils served as standards for tests of the clay in natural, heat-activated, and chemically activated states. All clays showed some bleaching ability in the natural state, but activation increased the bleaching power. These clays seemingly are suitable for commerical and industrial uses.--Auth.

3-632. McGrain, Preston, and others. MISCELLANEOUS CLAY AND SHALE ANALYSES FOR 1957-1959: In: Kentucky Geol. Survey, Ser. 10, Rept. Inv. 3, p. 1-57, 2 maps, 3 tables, 1960, 22 refs.

Physical characteristics and firing tests of 42 samples of clays and shales are presented in this report. Raw materials satisfactory for the manufacture of common and decorative face brick, structural, drain, and quarry tile, flue lining, sewer pipe, artware, stoneware, and refractories were located in the course of this study. Chemical analyses of 149 samples of clays and shales collected as a part of this and earlier investigations are included. --Auth.

3-633. Block, Douglas A. SAND AND GRAVEL RESOURCES OF KANE COUNTY, ILLINOIS: Illinois State Geol. Survey, Circ. 299, 11 p., 2 maps (1 in pocket), 5 tables, 1960.

Kane County contains numerous, extensive deposits of sand and gravel deposited by meltwaters from Wisconsinan age glaciers. These deposits are shown on a map where they are classified according to their probable character and mode of occurrence. The map is based mainly on observations of outcrops and on geological inferences founded on a knowledge of the glacial geology of the county. Sieve tests and pebble counts of 17 samples from gravel pits and outcrops give a general idea of the nature of the various types of deposits.--Auth.

3-634. Hewitt, D.F. THE LIMESTONE INDUSTRIES OF ONTARIO: Ontario, Dept. Mines, Indus. Mineral Circ. no. 5, 177 p., illus., 2 maps (in pocket), secs. (3 in pocket), diags., graphs, tables, 1960, refs.

This report reviews the production, specifications, uses, distribution, stratigraphy, and utilization of limestone and dolomite, together with quarry operations.

The report is divided into 5 chapters. Chap. 1, Introduction, briefly notes the importance of limestone as an industrial mineral in Ontario, its value and production exceeding all other industrial minerals. Its chief use is in the construction industry. It is also used for metallurgical flux, in the chemical industry, and smaller amounts in the glass, pulp, paper, sugar refining, and tannery industries, in the gold mining industry and in the uranium mills. In 1958, 5 quarries were each producing over 1,000,000 tons of stone per year.

Chap. 2, Production and Uses of Limestone in Ontario, contains tables showing production in 1958 was valued at $18 million, production by uses, and a list of limestone producers grouped according to tonnage. This is followed by reviews of the cement and lime industries in Ontario with tables of production and producers.

Chap. 3, Specifications and Uses of Limestone and Dolomite, contains information on tests for stone, including grading tests, petrographic examination, soundness tests, abrasion tests, absorption and porosity, reactivity tests, incompatibility tests, loss on washing, density, strength, stripping tests, and chemical analysis. Specifications for limestone are described under 8 uses: crushed stone, portland cement manufacture, lime manufacture, flux stone, building stone, riprap, pulverized stone, pulp and paper industry.

Chap. 4, Distribution and Characteristics of Major Limestone Formations and Quarry Operations, forms a major part of the report. The limestone and dolomite formations of commercial interest are described in 6 sections: 1) Precambrian Grenville limestone and dolomite; 2) Beekmantown dolomite, [Lower Ordovician]; 3) Trenton-Black River limestones [Middle Ordovician]; 4) Guelph-Lockport dolomite [Middle Silurian]; 5) Bois Blanc limestone [Middle Devonian] and Bertie-Akron dolomite [Upper Silurian]; 6) Detroit River and Delaware limestones [Middle Devonian]. Under each of these sections is a description of the stratigraphy, followed by descriptions of quarries. Geological sections, chemical analyses, and quarry operation are given for each quarry.

Chap. 5, Utilization of Ontario Limestone Resources, discusses the characteristics and utilization of the various Ontario limestone formations under the headings: crushed stone industry, portland cement industry, lime industry, and flux, metallurgical and chemical stone. The chapter concludes with a brief discussion of reefs and reef structures.--Auth.

**3-635.** Ives, William, and Russell T. Runnels. **LIME RAW MATERIALS IN THE KANSAS CITY AREA: Kansas, State Geol. Survey, Bull. 142, pt. 3, p. 123-148, 2 figs., map (in pocket), 18 tables, 1960, 8 refs.**

Chemical analyses of channel samples from members of the Wyandotte limestone [Pennsylvanian], indicate 3 areas of high-purity limestone (96 to 98% carbonate) within 30 mi. of the industrial districts of Kansas City. These areas are worthy of commercial exploration as potential sources of raw material for manufacture of quick or hydrated lime. Known geologic, chemical, and economic factors affecting development are presented for each area. Basic lime manufacturing processes and the magnitude of the lime industry are summarized briefly.--Auth.

**3-636.** Risser, Hubert E. **KANSAS BUILDING STONE: Kansas, State Geol. Survey, Bull. 142, pt. 2, p. 53-122, 26 illus., map, 2 graphs, 4 tables, 1960, 24 refs.**

From the earliest pioneer days stone has been a useful building material within the state of Kansas. Reported value of dimension stone, mainly limestone, produced annually now amounts to several hundred thousand dollars.

Building stone is produced at widely scattered points across the state. Most of the stone produced each year comes from limestone beds of Permian age, but Pennsylvanian, Cretaceous, and Tertiary rocks are also quarried, and Quaternary glacial deposits provide boulders for some structures. Quarrying methods are described.

Kansas stone-processing plants produce stone in every degree of finish. In recent years, production has trended toward cut and finished stone and away from rough building stone.

As timber becomes scarcer and more expensive there is a likelihood that stone will become more widely used in buildings of all types.--Auth.

**3-637.** Eckel, Edwin B. **PUMICE AND POZZOLAN DEPOSITS IN THE LESSER ANTILLES. With a report on Tests of Pumice, Lesser Antilles, Miscellaneous Paper No. 6-400, by U.S. Waterways Experiment Station, Vicksburg, Mississippi: U.S. Geol. Survey, Repts., Open-File Ser., no. 592, 58, 22 p., 4 maps, tables, Sept. 1960, 16 refs.**

Three very large deposits of pumiceous material are known to exist in the Lesser Antilles - on Dominica, Martinique, and St. Eustatius. Other and somewhat less promising deposits of pumice, pumicite, volcanic cinders and pozzolanic earths are known on the same and several other islands.

Both the Martinique and St. Eustatius deposits were, at the time this report was prepared, under option to American interests. So far as known, the Dominica deposit has not yet been investigated thoroughly by private interests and there are no known plans for its exploitation. Each of the 3 main deposits is large enough and accessible enough to be amenable to large-scale open-cut mining. Each is close to sea transportation.

The Martinique deposit is made up almost entirely of coarse lump pumice. This would require only crushing and screening to meet ASTM specifications for lightweight coarse aggregate. Production of fine aggregate would require further crushing; if fine-grained pumicite is desired, all of the Martinique material would require grinding and sizing.

The Dominica and St. Eustatius deposits contain both fine and coarse pumice. Acceptable fine and coarse lightweight aggregate could be prepared from both deposits by crushing and sizing. The St. Eustatius material, however, is heavier than that on Dominica and approaches the upper limit for unit weight as lightweight aggregate. This difficulty can probably be overcome by removal of dense fragments of andesite or by rejection of part or all of the fines.

All 3 of the deposits can yield immense quantities of fine material with excellent pozzolanic properties. For this purpose, all of the Martinique product would require fine grinding and sizing. The fine fraction screened from the Dominica deposit would require comparatively little grinding. The St. Eustatius deposits are strongly pozzolanic only in part, so that selective mining of certain layers, or fine grinding of only the coarser fractions, would probably be needed to produce an acceptable pozzolan.

Further research is needed to determine the feasibility of producing pumice for other uses than concrete aggregate or pozzolan cement. Among the possible uses that bear investigation are for insulating and acoustical plasters, carriers for chemical fertilizers or insecticides, abrasives, and soil conditioners.

Large potential markets for lightweight aggregate exist in the Caribbean area itself, particularly on such islands as Puerto Rico, Curacao, Trinidad, and Jamaica, where construction is booming. With relatively cheap water transportation, even larger potential markets would seem to exist along the entire E. and Gulf coasts of the United States, where the building rate is ever-increasing and where lightweight aggregates of any kind are relatively scarce and high-priced.

Successful development and production of any of the Lesser Antilles deposits would have to take account of the following requirements, among others:

1) Proof, by means of field exploration and large-scale laboratory or plant tests, that the deposits are as large and as good in quality as presently available information indicates.

2) Proof that shipment of a product or products of constant quality can be assured over a long period.

3) Proof that the planned product or products can be sold at prices that compare favorably with those of competing products in the planned markets, with due allowance for shipping costs from the Lesser Antilles.--Auth. summ.

**3-638.** Busch, W. L. MINERAL PRODUCTION IN ILLINOIS IN 1959: Illinois State Geol. Survey, Circ. 300, 36 p., 5 maps, 3 graphs, 24 tables, 1960.

The amount and value of minerals produced in Illinois during 1959 and 1958 are summarized in tables, maps, and charts in this annual report. It is estimated that the total value of minerals produced in 1959 amounted to 603 million dollars. Revised values for 1958 totaled 611.6 million dollars. The minerals include coal, crude oil and associated products, stone, sand and gravel, fluorspar, metals, and such related items as clay products, cement, and lime.--Auth.

**3-639.** Thomson, Robert D., and others. THE MINERAL INDUSTRY OF PENNSYLVANIA IN 1958: Pennsylvania Geol. Survey, Inf. Circ. 36, 47 p., 17 tables, 1960.

This publication gives a complete review of the mineral commodities mined in each of Pennsylvania's counties, giving the quantities mined or quarried as well as the names of the major producing companies.

Pennsylvania's mineral output in 1958, was characterized by decreased and limited markets due to a widespread drop in state as well as national economy. Reflecting the adverse 1958 economy all major mineral industries declined in value of output. The production of bituminous coal, clays, Fe ore, and stone was affected by a drop in steel production; cement, clays, sand and gravel, and stone were affected by a decline in construction.

Information Circular 36 was prepared under a cooperative agreement for the collection of mineral data, excepting mineral fuels, between the Pennsylvania Dept. of Internal Affairs, Bureau of Topographic and Geologic Survey, and the U. S. Bureau of Mines.--A. R. Geyer.

**3-640.** Antropov, P. Ya. ON SOME ACHIEVEMENTS OF GEOLOGICAL SURVEYING AND PROSPECTING IN THE CHINESE PEOPLE'S REPUBLIC. Prepared by the U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 12, p. 1071-1077, Dec. 1960.

Oil and gas prospecting in China has located promising shows in Tertiary deposits of the Ts'aidam valley of southern China, and Kansu corridor, the Chungar trough of NW. China, and in Mesozoic deposits of the Turfang valley in Sikang.

The Fe content of Precambrian quartzite ores in northern China averages 47%. In 1957, 19 million tons of Fe ore were mined in China. Reports on recent products and prospects for future development are included for Mn, Sn, W, Cu, bauxite, Hg, Sb, Mo, Ni, Co, chromites, Ti, V, Au, rare earths, U, B, phosphorites, apatites, quartz, diamond, and asbestos.--M. Russell.

## 13. FUELS

See also: Areal and Regional Geology 3-436; Mineralogy 3-557; Igneous and Metamorphic Petrology 3-602, Geohydrology 3-609; Mineral Deposits 3-640; Engineering Geology 3-652, 3-653.

**3-641.** Brod, I. O. ON PRINCIPAL RULES IN THE OCCURRENCE OF OIL AND GAS ACCUMULATIONS IN THE WORLD. Translated by the author: Internat. Geology Rev., v. 2, no. 11, p. 992-1005, 5 maps, table, Nov. 1960, 53 refs.

Oil and gas fields of the world are universally associated with downwarping of sedimentary rocks. They occur in 3 principal types of depressions: 1) platform-plain, 2) piedmont, and 3) intermontane. Seven subgroups of occurrence are recognized. Approximately 130 actual or potential oil and gas basins are delineated in 3 major mountain belts and 2 major platform belts.--M. Russell.

**3-642.** Armon, William J., and O. W. Rees. CHEMICAL EVALUATION OF ILLINOIS OIL SHALES: Illinois State Geol. Survey, Circ. 307, 22 p., 2 diags., graphs, 11 tables, 1960, 27 refs.

Four Illinois black shales and one limestone (Decorah) were selected for detailed study of the chemical and physical characteristics of products (mainly oil and gas) produced by retorting. Assay yields ranged from 7.3 to 13.3 gallons of oil per ton of shale pyrolized. Data indicate that the conversion of organic matter to oil was comparatively low for the shales, ranging from 8.5 to 13.4%. The limestone from the Decorah formation [Middle Ordovician] showed a conversion of 58.9%.

Specific gravity of the crude oils ranged from 0.922 to 0.952. N measured from 1.61 to 2.02%. The oils from Illinois shales were high in S, which ranged from 0.82 to 2.42%. Viscosity values were strikingly lower than those reported for oils from Colorado shales.

Fractional distillation data for oils from Illinois shales show the naphtha fraction to be high and the residuum fraction to be low. Yields of gas averaged 660 cu. ft. per ton of shale, and the average heating value was 775 B.t.u. per cu. ft. Retort gases consisted chiefly of H (34.9%), methane (23.4%), and carbon dioxide (13.6%), the remainder being made up of lesser amounts of N, carbon monoxide, and other hydrocarbons.

Results reported provide information on characteristics of crude oils and gases from Illinois shales and serve as a basis for comparing shales and retorted shale products.--Auth.

**3-643.** Bell, Alfred H., and others. PETROLEUM INDUSTRY IN ILLINOIS, 1959. PART I. OIL

**AND GAS DEVELOPMENTS. PART II. WATER-FLOOD OPERATIONS: Illinois State Geol. Survey, Bull. 88, 127 p., 5 figs. incl. 2 maps (1 in pocket), graphs, 17 tables, 1960.**

Illinois produced 76,727,000 barrels of oil in 1959, a decrease of 5% from the 1958 production. Fifty-seven percent of the production (43,790,000) was estimated to have resulted from secondary recovery by waterflooding in 1959, an increase from the 53% of the total production reported in 1958.

Forty-eight percent of the 2,032 new holes drilled were completed as producing wells. Twelve oil pools, 2 gas pools, 43 extensions to pools, and 31 new pay zones in existing pools were discovered. One of them, the Harrodsburg limestone [Mississippian], had not been previously recognized as a pay zone in Illinois.

Twelve pools had extensive development during 1959, including 1 oil pool discovered during the year. Two of the 1959 oil discoveries opened a new oil producing area in western Illinois.

During 1959 a total of 499 controlled secondary recovery projects were reported in Illinois. The oil produced from these projects amounted to approximately 41,360,000 barrels, and an additional 2,430,000 barrels of oil was estimated to have been produced by dump flooding. At the end of 1959 the total cumulative waterflood oil produced in Illinois was 250,031,000 barrels.

Pressure maintenance projects added 1,110,000 barrels of oil to the state's production but this was not considered as secondary oil.

Reserves are estimated at 596.1 million barrels as of Jan. 1, 1960, 28.7 million barrels less than the estimate for Jan. 1, 1959.--Auth.

**3-644. Goebel, Edwin D., and others. OIL AND GAS DEVELOPMENTS IN KANSAS DURING 1959: Kansas, State Geol. Survey, Bull. 147, 254 p., 8 maps (3 in pocket), 7 graphs, 32 tables, 1960, 45 refs.**

Kansas oil production in 1959 totaled 119,473,875 barrels, a decline of 0.4% from the previous year. The 1959 output of crude oil decreased in value to $354,837,409 from $362,225,124 in the preceding year, because of both decreased production and decrease in average price.

Natural gas production in Kansas totaled 595.2 billion cu. ft. (14.65 p.s.i.a.), an increase of 11.1%; the Hugoton gas area produced 404.8 billion cu. ft., about 68% of the total.

During the year, 157 new oil fields, 39 new gas fields, and 2 that were both oil and gas fields were discovered; 8 previously abandoned fields were revived.

In 1959, a total of 4,778 wells was recorded as drilled in Kansas in connection with the petroleum industry. Of the recorded completions, 2,161 were oil wells, 194 were gas wells, 57 were both oil and gas, 1,994 were dry holes, and 372 were salt-water disposal wells or wells used as input wells in secondary recovery operations. Of the 1,994 dry holes, 627 were wildcats. Estimates of wells not specifically reported, but for which drilling permits were issued, bring the total number of wells drilled in the state during the year to 6,013.

In 1959, Barton County produced 11,404,683 barrels, and as in 1958 was the leading oil producing county. Ellis and Russell counties, ranked second and third, produced 11,222,654 barrels and 8,922,064 barrels respectively. The Bemis-Shutts field of Ellis and Rooks counties was the top-ranking field in the state. The 6 leading oil fields - Bemis-Shutts, El Dorado, Chase-Silica, Hall-Gurney, Trapp, and Kraft-Prusa - accounted for about 19% of the total annual production.

In 1959, Kansas fields produced 232.9 million gallons of natural gas liquids, valued at more than 12.2 million dollars. Proved reserves of natural gas liquids are nearly 197 million barrels.

The proved reserves of Kansas crude oil at the end of the year were 917.5 million barrels, or 0.5% less than the previous year's reserves. Proved reserves of natural gas are more than 19.9 trillion cu. ft.

Production from recorded secondary recovery projects in Kansas amounted to 11,798,569 barrels of oil during 1959, but allowance for projects not reporting boosts the total to an estimated 17.9 million barrels. An estimated total of 7,260 oil wells and 3,649 injection wells were active during the year. Butler County, which yielded 4,318,555 barrels, led in the amount of oil produced by secondary recovery methods.--Auth.

**3-645. Risser, Hubert E. COAL IN THE FUTURE ENERGY MARKET: Illinois State Geol. Survey, Circ. 310, 15 p., 11 graphs, 1960.**

A 5-fold increase in energy consumption has occurred in the United States since 1900. Population has increased to 2 1/3 times its 1900 level, and average per capita energy consumption is equivalent to more than 9 tons of coal per year, compared to about 4 tons 60 years ago.

Because of competition from other fuels, the coal industry has declined even though total energy consumption has increased. From now on the coal industry will move forward.

Competition will still prevent growth of coal in many uses, but projections of continued growth in its use for generating electric power will bring a significant increase in total coal consumption through the mid-1970's. This will help to strengthen the coal industry and enable it to face the opportunities and challenges of the last quarter of the twentieth century when the declining availability of oil and gas will open up new markets and reopen old markets.--Auth.

**3-646. Yingst, Parke O. COAL RESOURCES OF COLORADO: Colorado School Mines, Mineral Industries Bull., v. 3, no. 5, 8 p., map, chart, 6 tables, Sept. 1960, 28 refs.**

Based on studies by governmental and private agencies, the status of coal resources in Colorado is given in summary form. Comments are included on geology, classification, reserves, mining conditions, production, and future outlook.

Coal in Colorado ranges in age from lower Cretaceous to Paleocene and in rank from anthracite to lignite. Colorado coal fields are classified into the following units: Denver region, Raton Mesa region, North Park field, Canon City field, South Park field, Tongue Mesa field, San Juan River region, Green River region, and Uintah region. A geologic summary is given for each field, and a differentiation is made between explored and unexplored areas.

In coal reserves, Colorado ranks fourth among the Rocky Mountain states. Total Colorado reserves in beds of workable thickness and to a depth of 3,000 ft. are given as 81,784.63 million tons of subbituminous, bituminous, and anthracite coal. With existing mining methods, about 1/2 of this tonnage is recoverable.--W.C. Peters.

3-647. Osmundsen, John A. NEW COAL DEPOSITS DISCOVERED IN THE ANTARCTIC: New York Times, v. 110, no. 37,599, p. 7, cols. 3-5, map, Jan. 2, 1961.

Anthracite, in seams as thick as 8 ft., has been discovered near Mackay Glacier, 90 mi. from the base at McMurdo Sound. The deposits, although of no foreseeable economic potential, should help resolve questions of antarctic paleogeography, continental drift, and polar wandering, when their age has been determined.--M. Russell.

## 14. ENGINEERING GEOLOGY

3-648. Caldwell, Joseph M. DEVELOPMENT AND TESTS OF A RADIOACTIVE SEDIMENT DENSITY PROBE: U.S. Beach Erosion Board, Tech. Memo. no. 121, 29 p., 2 illus., diag., 2 graphs, 9 tables, Sept. 1960.

The development, calibration, and laboratory and field testing of an instrument for in-place determination of sediment density is described. The device encased in a submersible probe and utilizing 3 millicuries of Ra 226 as a source of radioactivity and 3 halogen-filled Geiger-Muller Counters to detect reflected gamma rays transmits a preamplified signal through a 75-ft. cable to a scaler, the signal being correlated to the density of the sediment-fluid mixture. The probe senses the in-place bulk density of sediment surrounding the probe over a sphere of material of about 1-ft. radius centered on the probe. Evidence is presented that this device is an accurate and practical tool for use in the field, and that its accuracy is greater and costs less than for other methods presently in use.--Auth.

3-649. CALTECH BUILDS EARTHQUAKE MACHINE: Am. Engineer, v. 30, no. 2, p. 43, illus., Feb. 1960.

A machine developed and built by California Institute of Technology engineers produces realistic earthquake effects such as fractures and other damage to full-size structures so that "quake-resistant" designs can be developed. The machine weighs about 500 lbs. including its 1 1/2 hp. motor. By utilizing weights up to 400 lbs. and regulating speeds of rotation between 4 and 500 r.p.m., it is possible to produce quakes of varying magnitude. By cracking real buildings under controlled conditions it is proposed to produce information that will make possible practical, economic designs for buildings, dams, and bridges that can survive earthquakes without damage.--R.M. Allen, Jr.

3-650. Izett, G.A. "GRANITE" EXPLORATION HOLE, AREA 15, NEVADA TEST SITE, NYE COUNTY, NEVADA - INTERIM REPORT, PART C, PHYSICAL PROPERTIES: U.S. Geol. Survey, Trace Elements Memo. Rept. 836-C, 37 p., map, diag., graph, 10 tables, Jan. 1960, 10 refs.

Physical properties measurements including porosity, density, permeability, magnetic susceptibility, and thermal conductivity were made on granite samples from the U-15A "Granite" exploration borehole, Nevada Test Site. Porosity values range from 0.4 to 4.8%, and density values range from 2.56 to 2.69 g./cc. (bulk density) and from 2.66 to 2.72 g./cc. (grain density) Permeability of fresh rock from the borehole is probably less than $10^{-13}$ millidarcies. Magnetic susceptibility measurements range from 0.36 to 3.48 x $10^{-3}$ c.g.s. units, and thermal conductivity values range from 5.6 to 8.1 c.g.s. units.--Auth.

3-651. A CENTURY-OLD DREAM LINKING ENGLAND AND FRANCE: Am. Engineer, v. 30, no. 6, p. 33-36, 62-63, 7 illus., June 1960.

Recently a Channel study group, composed of English, French, and American interests proposed construction of railway tunnels between Dover and Calais. Two parallel one-way tunnels for railway traffic and a smaller service tunnel between them was recommended. The traffic tunnels would have 21 ft. 4 in. internal diameter, and would be 32 mi. long, of which 23 mi. would be under water. The plan would cost about $300 million and would take 5 years to complete. Geological surveys have established the feasibility of boring a tunnel through the Lower Chalk formation which ranges in thickness between 213 and 262 ft. under the sea bed.--R.M. Allen, Jr.

3-652. Flanagan, D.A., and Paul B. Crawford. FEASIBILITY OF UNDERGROUND STORAGE OF LIQUEFIED METHANE: Jour. Petroleum Technology, v. 12, no. 6, p. 73-76, 4 illus., table, June 1960, 10 refs.

Storage of liquefied methane requires a safe and well insulated vessel. The purpose of this paper is to determine the feasibility of storing liquid methane underground in mined caverns. A formula for evaluating the heat flux into rock medium is developed. Both temperature distribution and heat flux vary with the thermal properties of the rock, cavern radius, and time.

The presence of earth gases and liquids near a storage cavern should be considered since they will solidify at some distance from the cavern cavity. Upon solidification, the temperature migration slows down.

Areas of rock types probably favorable for liquefied methane storage are: the northern portion of the Atlantic seaboard, the southern portion of the Atlantic seaboard, the Appalachian core, W. of the Appalachian core, the central region, the Rocky Mountain area, and the Pacific Coast area.--T.C. McLean.

3-653. Jewett, John M., and Edwin D. Goebel. UNDERGROUND STORAGE OF NATURAL GAS IN KANSAS: Kansas, State Geol. Survey, Oil & Gas. Inv. no. 21, 18 p., 4 maps, sec., 2 tables, 1960, 37 refs.

Kansas produces large amounts of natural gas, and large quantities are consumed within the state, especially in the eastern part. At present gas is stored in 14 projects. Geologic conditions in the state are such that possibilities for storage in more underground reservoirs is very promising.--Auth.

3-654. Reichert, Stanley O. CASE HISTORY STUDIES OF HOW GEOLOGY AND HYDROLOGY INFLUENCE NUCLEAR REACTOR SITE LOCATIONS

**IN FLORIDA: Southeastern Geology, v. 2, no. 1, p. 23-41, 10 maps, chart, 2 secs., Aug. 1960, 6 refs.**

Three different projects concerning site location studies for proposed nuclear reactors to be located in different parts of Florida are discussed. One project involved a generalized and detailed study of the geologic and hydrologic factors of importance in evaluating a pre-selected area near Pierce, about 35 mi. E. of Tampa. A second project involved a similar study of the Ft. Pierce area on the lower E. coast. A third project was to find the most favorable sites, geologically and hydrologically, in the broad area including Dixie, Levy, Citrus, and Marion counties.

Favorable geologic and hydrologic factors influencing the safety factors inherent in a given site location were used to evaluate the various possible reactor site locations. These factors were: 1) quantity and quality of surface and ground water available at any location, 2) topography and drainage characteristics, 3) population affected in the event of accidental spillage of radioactive liquids or solids to the ground, 4) porosity and permeability of the soil and bedrock at each locality, 5) downstream hazard in the event of radioactive contamination of surface or ground water, 6) possible protection the soils may afford toward radioactive decontamination due to their clay content, and 7) radioactive dilution potential of surface and ground water in each area.

Several areas in Citrus and Levy counties are identified as having the most favorable geologic and hydrologic characteristics from the standpoint of safety. To these advantages, engineering and economic factors were added to give an over-all rating in each general area.--Auth.

**3-655. Bycroft, G.N. YIELD DISPLACEMENTS IN MULTISTORY ASEISMIC DESIGN: Seismol. Soc. America, Bull., v. 50, no. 3, p. 441-453, diag., graphs, July 1960, refs.**

This paper investigates the plastic displacements occurring when certain types of elastoplastic multistory shear structures are subjected to large earthquakes. It is directed toward finding a variation of the horizontal stiffness and strength up the structure in order to minimize yield displacements and distribute them over the structure. The analysis has been made on an analog computer using a white noise source to simulate the earthquake disturbance.--Auth.

**3-656. Bycroft, G.N. EFFECT OF STIFFNESS TAPER IN ASEISMIC DESIGN: Seismol. Soc. America, Bull., v. 50, no. 4, p. 537-552, diag., 16 graphs, Oct. 1960, 3 refs.**

An investigation is made of the effect of changing the stiffness distribution up the height of a linear shear framed structure when subjected to idealized earthquake motions. The mean value of the largest strains arising in successive earthquakes is determined together with the associated probability distribution. It appears that the chances of finding a strain value greater than twice the mean are very small.--Auth.

**3-657. Brawner, C.O. THE LANDSLIDE PROBLEM IN B.C. HIGHWAY CONSTRUCTION: B.C. Prof. Engineer, v. 11, no. 3, p. 11-17, 5 illus., table, March 1960, 4 refs.**

Analysis of the landslide problem in British Columbia consists of a) assessment of stability of surfaces along proposed highway locations, b) preventive measures during construction, and c) stabilization of active landslides.

Assessment of stability requires determination of the history of landsliding along proposed routes from sources such as air photos, local residents, and field inspection. Field inspection includes study of the type slide (e.g. block, rotational, etc.) and amount of movement; study of local drainage and geology; and efforts to determine such subsurface data as depth of water table, depth and shape of failure zone, and location of underground seepage channels.

The guiding principle for prevention of landslides is that construction should be carried out in a manner that will cause the least disturbance to the normal forces of nature, such as drainage patterns. Special attention should be given the strength of highway fills, and the control of surface and subsurface runoff (e.g., by the efficient use of culverts).

If economic considerations permit, the slide may be stabilized. Commonly used methods include counterbalancing, surface and subsurface drainage, construction of retaining structures, and slope seeding.--J.H. Howard.

## 15. MISCELLANEOUS

**3-658. Harrison, A.E. EXPLORING GLACIERS - WITH A CAMERA: 71 p., 60 illus., 2 diags., Sierra Club, Mills Tower, San Francisco 4, California, 1960.**

The opportunity afforded the mountain climber to provide a valuable record for glacial studies is explained. There is a brief nontechnical discussion of glacial features and observations and an interpretation of glacial behavior but major emphasis is on the techniques of photographing glaciers which will provide glaciologists with the necessary records to study ice motion, response of glaciers and other ice bodies to a change in climate, and the nature of a climatic change which can affect a glacier.--M. Russell.

**3-659. Hastings, Earl L. BIBLIOGRAPHY OF ALABAMA GEOLOGY, 1935-1958: Alabama, Geol. Survey, Bull. no. 67, 138 p., 1960.**

This bibliography of 1,235 references provides a list and index to published and a few unpublished references on Alabama geology. Such subjects as mining, ground-water geology, mineral beneficiation, cave descriptions, oil and gas exploration, soil surveys, fossils, mineral deposits, and physical features are included.

A few references prior to 1935, not included in either of Roland M. Harper's bibliographies of Alabama geology (Alabama, Geological Survey, Bulls. 42, 44), are listed for completeness. The "Supplementary Bibliography of Alabama Geology," (Bull. 44) has been included in its entirety because copies of this publication are exhausted.

No attempt was made to find all general references that mention Alabama geology. However, a few general references were listed when they were encountered.--From introd.

The references are listed alphabetically by author under year of publication. The items are numbered continuously and indexed by number.

3-660. Reichert, William H. BIBLIOGRAPHY AND INDEX OF THE GEOLOGY AND MINERAL RESOURCES OF WASHINGTON, 1937-1956: Washington, Div. Mines & Geology, Bull. no. 46, 1960.

This compilation of approximately 2,800 references consists of 3 parts: bibliography, index, and appendix. The bibliography includes articles on the geology and mineral resources of Washington, published during the period Jan. 1, 1937 - Dec. 31, 1956. The articles are arranged chronologically under each author's name. Abstracts, reviews, criticisms, and discussions of articles are included with the articles.

The appendix consists of 2 sections: A) a bibliography and index of theses, special papers, and reports of colleges and universities of the U.S. which deal with the geology and mineral resources of Washington, and a list of abstracts of theses; and B) a list of other unpublished reports and papers which deal with the above subjects.--From auth. introd.

3-661. Scandinavian Council for Applied Research. SCANDINAVIAN RESEARCH GUIDE. DIRECTORY OF RESEARCH INSTITUTIONS WITHIN TECHNOLOGY AND SCIENCE EXCLUSIVE OF LIFE SCIENCES: 2 v., Gaustadalleen 30, Blindern, Norway, [1960].

This directory covers research institutions in Denmark, Iceland, Finland, Norway, and Sweden. For more than 1,500 institutions the following information is given: name, address, telephone, name of head, number of staff, activities, policy concerning contracts, and serial publications. Five categories of institutions are distinguished: research institutes, central research organizations, universities and institutes of technology, information centers, and scientific societies. In the fields mineralogy, geology, and geotechnics, there are cited 43 research institutes, 6 central research organizations, and 6 scientific societies.--M. Russell.

3-662. Hackman, Robert J. THE ISOPACHOMETER - A NEW TYPE PARALLAX BAR: Photogramm. Eng., v. 26, no. 3, p. 457-463, diags., June 1960.

The isopachometer is a new parallax measuring device that utilizes 2 floating dots superimposed on the stereoscopic model of 2 vertical aerial photographs. The floating dots can be set to a specific vertical interval which may be moved up or down within the stereoscopic model. The isopachometer was designed mainly as an aid in geologic mapping, but should be applicable in other fields where interval measurements are required. The instrument also may be used like any standard parallax bar, in which a single floating dot is the only reference mark. --Auth.

3-663. Howard, Arthur David. THE CORRECTION GRAPH IN PHOTOGEOLOGY: Photogramm. Eng., v. 26, no. 3, p. 412-424, 6 figs., June 1960, 17 refs.

The correction graph is a misunderstood and neglected tool in photogeology. When prepared and used properly, it contributes to more accurate determinations of height, inclination of slopes, and dip of strata. An explanation of its theory and application is presented. Certain modifications of the computation form are discussed, and the problem of the best values of the photo base (b) and flying height (H) are considered. A linear interpolation procedure based on 11 control points is presented as an alternative to Visser's more complicated parabolic interpolation procedure. An explanation is offered of the procedure whereby the reading of the parallax bar is increased when the floating mark is moved into areas of increasing distortion, and decreased when the mark is moved into areas of decreasing distortion.--Auth.

3-664. Laurence, William L. A.A.A.S. REPORTS: New York Times, v. 110, no. 37,598, Sec. 4, p. 8E, cols. 7-8, fig. Jan. 1, 1961.

Many papers in the physical and social sciences, covering subjects from scientists in China to the earth's radiation belts, were given the week of Dec. 26-30, 1960 at the annual meeting of the American Association for the Advancement of Science. Significant contributions in the geological sciences were 1) an estimate of China's mining and metallurgical potential, by Kung-Ping Wang, 2) reports of recent discoveries of large deposits of non-ferrous ores and coal in China, by Edward C.T. Chao, and 3) an announcement of plans to proceed with the first phases of drilling the Mohole, by Alan T. Waterman and Detlev W. Bronk.--M. Russell.

3-665. American Geological Institute. MINERAL, FOSSIL & ROCK EXHIBITS, AND WHERE TO SEE THEM: 61 p., Washington, D.C., [1960].

This booklet contains an annotated listing of 12 museums in Canada and 167 museums in the United States which contain exhibits of geologic interest. These public museums are presented alphabetically by province and state. Standard information is listed for each museum, including the name, address, visiting hours, admission fees, types of geological exhibits, and curators. In addition, there is a short annotation describing the outstanding features of geological displays.--From foreword.

3-666. American Geological Institute. SURVEY OF GEOLOGY-GEOPHYSICS STUDENTS IN THE COLLEGES AND UNIVERSITIES OF THE UNITED STATES AND CANADA IN 1959-60: Its: Rept. 12, 1960 ed., 13 p., 2 graphs, 3 tables, [1960].

The 5th in a series of annual reports. A fairly stable student population in the geosciences remains in Canadian schools, but a serious drop in junior and senior level enrollment is reported in the United States, reflecting the poor employment status of the last few years. Masters degree candidates increased in Canada, but dropped by almost 10% in the U.S.; enrollment in the Ph. D. program showed general increase. A new feature of the survey shows that for every geology major, there are 6 nonmajor students taking geology as part of their general education. Statistical presentation relates specific institutions to the number of students, classified into 6 levels of undergraduate and graduate study.--M. Russell.

# AUTHOR INDEX

Abstract

Allen, Clarence R. 3-445
American Geological Institute 3-665, 3-666
Antropov, P. Ya. 3-640
Appleman, Daniel E. 3-561
Armon, William J. 3-642
Armstrong, John E. 3-369
Arntson, R.H. 3-528
Asano, Gorō 3-602
Atherton, Elwood 3-477
Axelrod, Daniel I. 3-495

Bailey, Edgar H. 3-548
Barnes, W.H. 3-564
Bass, Manuel N. 3-473
Battey, M.H. 3-469
Becker, Bill 3-542
Bell, Alfred H. 3-643
Bell, Walter A. 3-476
Belov, N.V. 3-559, 3-562, 3-563
Berg, Joseph W., Jr. 3-522
Bergmann, H.J. 3-502
Bilgrami, S.A. 3-581, 3-590
Block, Douglas A. 3-633
Bloxam, T.W. 3-603
Bolton, Thomas E. 3-487
Bramkamp, R.A. 3-426
Brawner, C.O. 3-657
Brod, I.O. 3-641
Bromery, Randolph W. 3-420 through 3-425
Brune, James N. 3-516
Busch, W.L. 3-638
Butzer, Karl W. 3-462
Bycroft, G.N. 3-655, 3-656

Cady, Wallace M. 3-474
Caldwell, Joseph M. 3-648
California, Division of Mines 3-618
Campbell, R.B. 3-372
Canada, Geological Survey 3-352 through 3-368
3-376, 3-377, 3-378
3-381 through 3-412
Carson, Charles E. 3-456
Chaffee, Robert G. 3-588
Chao, Edward C.T. 3-544
Charters, A.C. 3-468
Chesnokov, B.V. 3-624
Christ, C.L. 3-558
Claire, C.N. 3-465
Clark, Evelyn N. 3-607
Clark, Joan R. 3-558, 3-561
Coats, Robert R. 3-545
Compton, Robert R. 3-601
Connell, James F.L. 3-472
Coogan, Alan H. 3-480
Cooper, Byron N. 3-623
Copeland, M.J. 3-487
Cotton, C.A. 3-458
Craig, D.C. 3-586
Crawford, Paul B. 3-652
Crickmay, C.H. 3-496
Crowley, Frank A. 3-626

Davis, Gregory A. 3-577
Davis, T. Neil 3-511
Deresiewicz, Herbert 3-518
Desautels, Paul E. 3-554
DeVries, R.C. 3-553
Dietrich, Richard V. 3-587
Dillinger, Lee 3-547
Donaldson, J.A. 3-379, 3-413
Dorf, Erling 3-444
Dunne, James A. 3-523

Eade, K.E. 3-414
Eckel, Edwin B. 3-637
Ergun, Sabri 3-557
Evernden, Jack F. 3-533

Fahrig, W.F. 3-373
Faulring, G.M. 3-525

Abstract

Feder, Allen M. 3-459
Ferguson, R.B. 3-529
Flanagan, D.A. 3-652
Flinn, Edward A. 3-508
Foster, Margaret D. 3-582
Foster, Robert J. 3-599
Frarey, M.J. 3-380
Fraser, J.A. 3-374
Frebold, Hans 3-486
Frondel, Clifford 3-569
Frye, John C. 3-485
Fyfe, William S. 3-526

Gabrielse, Hubert 3-371
Gibbs, G.V. 3-579
Giles, Eugene 3-492
Gilman, Ralph 3-504
Goebel, Edwin D. 3-644, 3-653
Goldsmith, Julian R. 3-527
Goldsmith, Richard 3-447
Gordon, Ellis D. 3-614
Graf, Donald L. 3-536 through 3-540
Gray, Carlyle 3-419
Griffin, Margaret S. 3-607

Hackman, Robert J. 3-662
Hall, Clarence A., Jr. 3-466
Hamilton, Warren B. 3-596
Hamlin, Howard P. 3-628
Harbaugh, John W. 3-605
Harker, Peter 3-479
Harrison, A.E. 3-658
Hastings, Earl L. 3-659
Heath, James P. 3-455, 3-608
Heezen, Bruce C. 3-470
Henderson, E.P. 3-463
Hendrickson, G.E. 3-609
Heusser, Calvin J. 3-451
Hewitt, D.F. 3-634
Hill, Walter E., Jr. 3-631
Hoare, Richard D. 3-484
Hood, James W. 3-615
Howard, Arthur David 3-663
Howard, Calhoun L.H. 3-571
Howie, R.A. 3-590
Hughes, R.J., Jr. 3-464
Hull, Frank M. 3-488
Hussey, Keith M. 3-456

Ilyukhin, V.V. 3-563
Ingram, R.E. 3-507
Ives, William 3-631, 3-635
Izett, G.A. 3-650

Jamieson, John C. 3-527
Jewett, John M. 3-653
Jimenez de Abeledo, M. 3-578
Johnson, Ralph G. 3-483
Jonas, Edward C. 3-584

Kelsey, C.H. 3-564
Kerr, Paul F. 3-523, 3-549, 3-571
Kesling, Robert V. 3-494
Krieger, R.A. 3-609
Krutikhovskaya, Z.A. 3-499
Kullerud, Gunnar 3-568
Kurata, Nobuo 3-617
Kushiro, Ikuo 3-580
Kuzhelov, G.K. 3-499

Labrador Mining and Exploration Co. 3-413
Lamar, J.E. 3-629
LaMoreaux, P.E. 3-612
Langenheim, Ralph L., Jr. 3-475
Lathram, E.H. 3-418
Laurence, William L. 3-664
Lee, Hulbert A. 3-415
Leech, G.B. 3-370
LeGrand, Harry E. 3-443
Leighton, Morris M. 3-448

Abstract

Leonard, A. Byron ........ 3-485
Levinson, Alfred A. ........ 3-570
Lockwood, W.N. ........ 3-450
Longshore, John D. ........ 3-598
Loughnan, F.C. ........ 3-586
Lutz, H.J. ........ 3-454

McGrain, Preston ........ 3-632
McKenna, Malcolm C. ........ 3-489
Macpherson, J.D. ........ 3-520
Marsh, Owen T. ........ 3-433
Matthews, Samuel W. ........ 3-512
Meisler, Harold ........ 3-450
Mero, John L. ........ 3-620
Milkey, Robert G. ........ 3-566
Millman, Anthony P. ........ 3-572
Minato, Masao ........ 3-478
Molloy, Martin W. ........ 3-549
Morrill, Philip ........ 3-588
Moxham, R.L. ........ 3-535
Mullens, Thomas E. ........ 3-437
Mulligan, Robert ........ 3-625
Murata, K.J. ........ 3-532

Nafe, John E. ........ 3-516
Navias, Louis ........ 3-546
Nemoto, Tadahiro ........ 3-595
Newell, Norman D. ........ 3-606
Nichols, Rachel H. ........ 3-482
Nickel, Ernest H. ........ 3-575
Nuffield, E.W. ........ 3-552

Ontario, Dept. of Mines ........ 3-381 through 3-410
O'Rear, David M. ........ 3-610
Osmundsen, John A. ........ 3-593, 3-647
Ostrom, Meredith E. ........ 3-585

Parham, Walter E. ........ 3-630
Patchett, J.E. ........ 3-552
Pearson, G. Raymond ........ 3-534
Peck, Dallas L. ........ 3-434
Peterson, P. ........ 3-505
Petrushevsky, B.A. ........ 3-510
Péwé, Troy L. ........ 3-453
Pistorius, Carl W.F.T. ........ 3-524
Ploch, Richard A. ........ 3-494
Poole, W.H. ........ 3-428
Powers, Howard A. ........ 3-574

Radoslovich, E.W. ........ 3-556
Ramirez, Leon F. ........ 3-426
Reeder, H.O. ........ 3-613
Rees, O.W. ........ 3-642
Reichen, Laura E. ........ 3-573
Reichert, Stanley O. ........ 3-654
Reichert, William H. ........ 3-660
Reiner, Ernst ........ 3-452
Reitan, Paul H. ........ 3-471
Reynolds, John H. ........ 3-530
Richard, B.H. ........ 3-467
Risser, Hubert E. ........ 3-636, 3-645
Roberson, Herman E. ........ 3-584
Robinson, S.C. ........ 3-622
Rogers, John J.W. ........ 3-598
Roman, Irwin ........ 3-503
Roy, Supriya ........ 3-589
Rukhin, L.B. ........ 3-446
Rumanova, I.M. ........ 3-562
Runnels, Russell T. ........ 3-635
Ryzhenko, L.M. ........ 3-621

Sackett, William M. ........ 3-541
Sanborn, Albert F. ........ 3-432
Satô, Yasuo ........ 3-519
Satterly, J. ........ 3-431
Savage, Donald E. ........ 3-493

Abstract

Savolanti, A.O.M. ........ 3-543
Scandinavian Council for Applied Research ... 3-661
Sclar, Charles B. ........ 3-547
Seki, Yôtarô ........ 3-576
Sen, Sisir K. ........ 3-531
Shapley, A.H. ........ 3-497
Sharp, W.E. ........ 3-457, 3-524
Shaw, D.M. ........ 3-534, 3-550
Shchukin, I.S. ........ 3-440
Shepps, Vincent C. ........ 3-419
Shimoda, Susumu ........ 3-583
Shor, George G., Jr. ........ 3-521
Shubnikov, A.V. ........ 3-551
Simons, Elwyn L. ........ 3-490
Simpich, Frederick, Jr. ........ 3-591
Siple, George E. ........ 3-435
Smirnov, V.I. ........ 3-621
Smitheringale, W.G. ........ 3-429
Socolow, Arthur A. ........ 3-500
Spiridonov, A.I. ........ 3-442
Stauder, William V. ........ 3-513, 3-514, 3-515
Steinbrugge, Karl V. ........ 3-465
Stevens, Rollin E. ........ 3-548
Stirton, R.A. ........ 3-491
Stott, Donald F. ........ 3-427
Sudo, Toshio ........ 3-583
Sullivan, Walter ........ 3-501
Switzer, George S. ........ 3-573

Tanner, William F. ........ 3-460, 3-461
Tateiwa, Iwao ........ 3-438
Terriere, Robert T. ........ 3-436
Thomson, Robert D. ........ 3-639
Thornton, Charles P. ........ 3-597
Thorsteinsson, R. ........ 3-479
Tilling, Robert ........ 3-560
Ting, William S. ........ 3-495
Tischler, Herbert ........ 3-475
Tocher, Don ........ 3-465
Tomita, Tōru ........ 3-600
Toulmin, Lyman D. ........ 3-612
Tuttle, O. Frank ........ 3-597
Tyni, M.H. ........ 3-543

Uotila, Urho A. ........ 3-498

Van Houten, Franklyn Bosworth ........ 3-604

Walker, George P.L. ........ 3-594
Warman, James C. ........ 3-611
Watanabe, Takeo ........ 3-619
Watt, P.A. ........ 3-506
Weeks, Ludlow J. ........ 3-375
Weihaupt, John G. ........ 3-439
Wheeler, John O. ........ 3-416, 3-417
White, George W. ........ 3-449
White, W. Arthur ........ 3-629
Whitten, Charles A. ........ 3-465
Williams, Howel ........ 3-592
Williamson, D.R. ........ 3-627
Willis, David E. ........ 3-517
Wilson, James T. ........ 3-517
Winchell, Horace ........ 3-560
Wuensch, Bernhardt J. ........ 3-555
Wynne-Edwards, H.R. ........ 3-413

Yingst, Parke O. ........ 3-646
Young, E.J. ........ 3-574
Young, W.L. ........ 3-430

Zacher, Edwin G. ........ 3-465
Zaytsev, I.K. ........ 3-616
Zeigler, John M. ........ 3-481
Zekkel, Ya. D. ........ 3-441
Zen, E-an ........ 3-474
Zoltai, Tibor ........ 3-567
Zvyagin, B.B. ........ 3-565